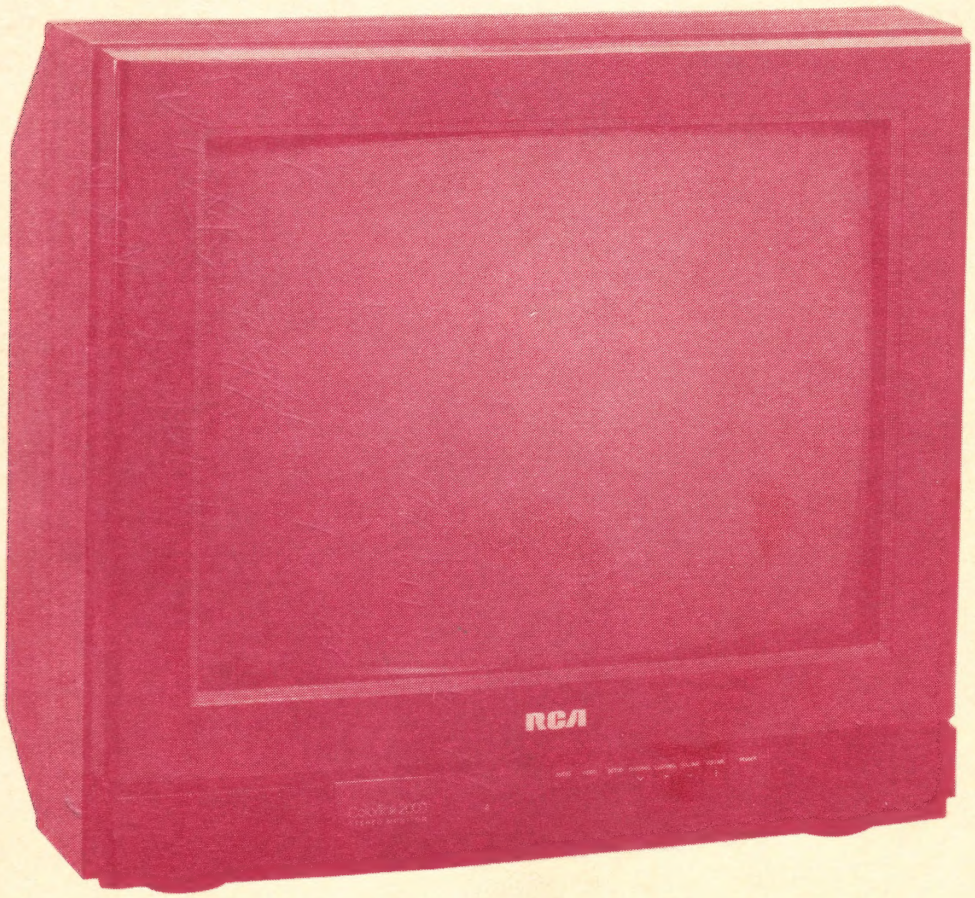
The CTC156/157/158/159 Technical Training Manual



RCA

Thomson Consumer Electronics, Inc./ Technical Training/P.O. Box 1976, Indianapolis, IN 46206

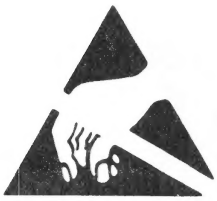
FOREWORD

This Technical Training manual familiarizes service technicians with the circuits used in RCA and GE Brand color televisions using the CTC156/157 and CTC158/159 chassis. This manual contains cirucit descriptions and service procedures developed to aid the service technician during troubleshooting and servicing CTC156/157 and CTC158/159 television receivers. This manual also contains information on general troubleshooting techniques and several appendices. The appendices include: a frequnecy and bandswitch state chart, microcomputer pin designations, analog interface unit (AIU) pin designations, test point location guides, and in-circut resistance measurements for the color television processing IC U1001.

Note: This publication is intended to be used only as a training aid. It is not intended to replace service data. RCA and GE Service Data for these instruments contains specific information about parts, safety, and alignment procedures and must be consulted before performing any service.

SAFETY INFORMATION CAUTION

Safety information is contained in the appropriate RCA or GE Service Data. All product safety requirements and testing must be complied with prior to returning the intrument to the consumer. Servicers who defeat safety features or fail to perform safety checks may be liable for any resulting damages, and may expose themselves and others to possible injury.



All integrated circuits, all surface mounted devices, and many other semiconductors are electrostaticall sensitive and therefore require special handling techniques.

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RCA
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INTRODUCTION

The CTC156/157 and the CTC158/159 series color television chassis are the latest additions to the RCA and GE brand Unitized Chassis family. Like the CTC148/149, the CTC156/157 and the CTC158/159 chassis series result from the integration of the technologies employed in the CTC140 and the CTC135/136 chassis families.

Chassis Variations
The CTC156 and the CTC158 chassis are used in models with 20″ picture tubes. The CTC157 and CTC159 chassis are used in models with both 26″ and 27″ picture tubes. The CTC156 and CTC157 are covered in one service data, and the CTC158 and CTC159 chassis are also covered in one data. The CTC156 and CTC157 are nearly identical with differences in the deflection circuits that vary according to screen size. Similarly, the CTC158 and CTC159 are nearly identical with differences in the deflection circuits varying with the screen size.

Though there is a great deal of similarity between the CTC156/157 and the CTC158/159 chassis families, they are distinct chassis. The major difference is due to the CTV processing IC U1001. The CTC156/157 chassis is used in the low end of the product line, and the CTC158/159 is used in models in the middle of the product line. The step up features included in the CTC158/159 chassis require the use of a different 64-pin CTV processing IC. The pin designations are different for the different IC's. The manual contains circuit descriptions based on the CTC158/159, and the pin designations may be different for U1001 in the CTC156/157 chassis. Refer to the appropriate service data for the correct pin numbers.

Troubleshooting the Chassis

Good troubleshooting skills are required for effective servicing of sophisticated electronic equipment. Troubleshooting is defined as locating and diagnosing malfunctions and breakdowns in equipment by means of logical analysis and systematic checks. A service technician must apply the principles of logical thinking and systematic checking in order to service most effectively.

Following a set of basic steps helps to organize thoughts into a logical pattern and reduce the amount of time spent performing systematic checks. The following are the basic steps of troubleshooting:

1. Confirm that the set is properly connected and adjusted for normal operation.
2. Document all service, using notes to help organize thoughts and record findings for future reference.
3. Perform a complete operational check. Verify the reported symptom and list what the unit will and will not do.
4. Classify the symptom and **sectionalize** the problem. Many technicians sectionalize the malfunction without being aware of the process. For example, it is not necessary to check the chroma circuit, if a set comes in with an audio problem. The malfunction is determined to be in the audio section without taking any measurements. Similarly, other malfunctions make the process of sectionalizing seem unnecessry. However, some symptoms such as a dead set could be caused by many different circuit areas, and the process of sectionalizing the symptom is needed. Identify the major functional group or area that could cause the problem. Use the information from step 3 to determine the most likely fault areas and eliminate those areas that could not cause the problem. This can often be done without removing the back cover from the instrument.
5. **Localize** the problem within the major circuit area. Divide the circuit in half and make voltage and waveform checks. If the circuit tests are good at the halfway point, the problem has to be located between this point and the output. If the circuit tests are bad at the halfway point, the problem is located between this point and the input. By repeatedly dividing the circuit in half, the problem can be isolated quickly.

   In circuits where feedback loops are used, this technique may also be used provided the feedback loop is broken and circuit conditions are established to allow the circuit to operate in a known mode.

   Other useful techniques include substituting externally generated DC voltages or waveforms, jumpering around suspected circuit areas, and forcing operation by substituting DC voltages for certain control signals.
6. **Isolate** the problem to the stage or component level. Make detailed voltage, waveform, and resistance measurements as required. Look for visible signs of damage and listen for unusual noises.

7. Once the defective component or components have been replaced, confirm normal operation.

Using the principles outlined in these steps, servicers will be able to effectively service most malfunctions.

Preparation for Service

When preparing to service an instrument, obtain the appropriate service data for the instrument being serviced. Do not assume that the service data for a similar instrument is close enough. Service data contains specific part, safety, and alignment information that varies with different models.

Always use the Service Data schematics when performing the detailed checks mentioned previously. The block diagrams and simplified schematics contained in Technical Training Manuals may not contain enough information to properly diagnose the malfunction. Technical Training Manuals are a service aid and not a substitute for Service Data.

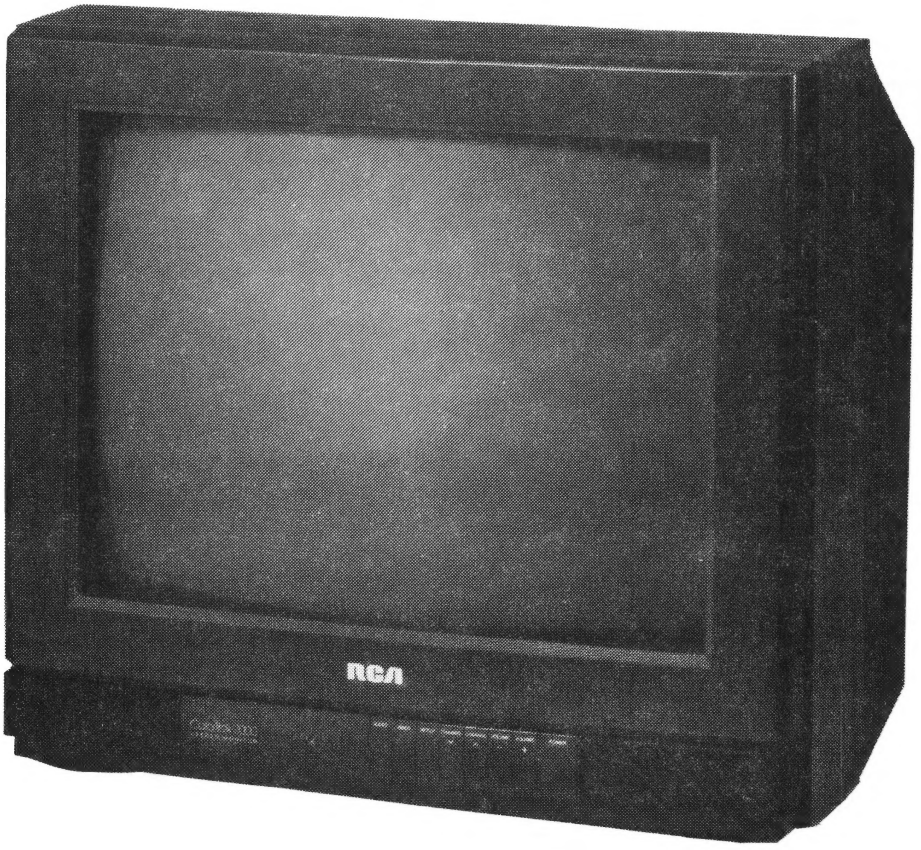
Modern consumer electronic products are capable of a wide variety of features and functions. Without knowing the capabilities of a particular instrument, it is difficult to determine if the instrument is malfunctioning or if the problem is due to operator error. Having a copy of the owners manual or being familiar with the capabilities of the set can be just as important as obtaining the correct service data. Copies of the owners manual are furnished on microfiche.

Documenting Service

Documentation is an important tool to simplify and organize service procedures. Many servicers make notes directly on the service data schematics. These notes are available each time a specific type of instrument is serviced.

Another method of documentation is to use a standard form or notebook and record specific information pertaining to an instrument. A good form can provide many benefits to a servicer. The forms help the servicer to systematically test a set and encourage logical thinking.

Once service is completed, forms can be filed by model or chassis number and can be used when servicing instruments with similar symptoms. The use of these forms enables the servicer to keep an accurate record of tests preventing back-tracking into previously tested areas. If the servicer is forced to stop working on a unit in the middle of troubleshooting, it is simple to determine where the diagnosis left off. Billing and/or warranty information can be taken directly from the form.



RCA F20680WN Color Television Receiver

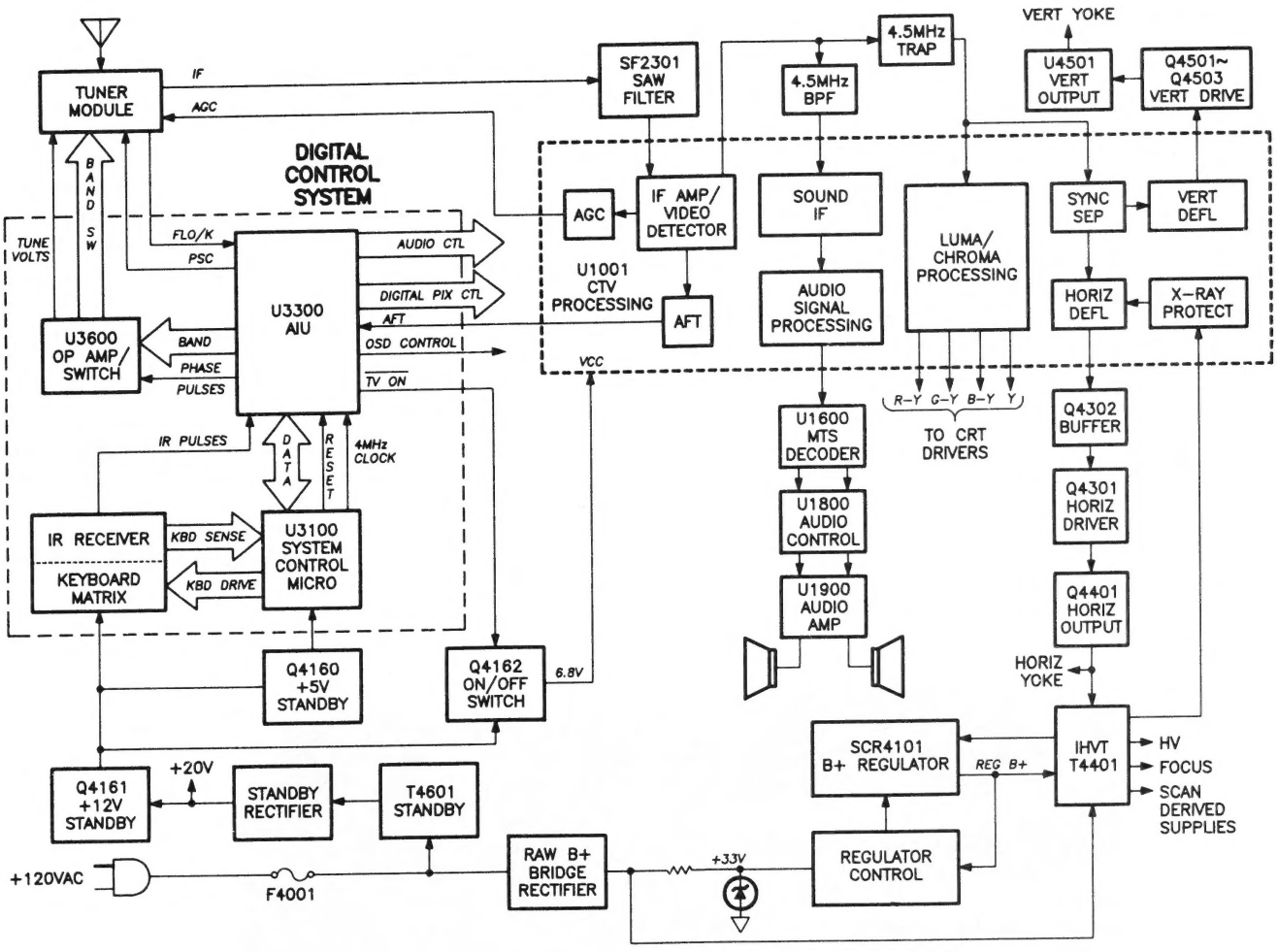


Fig. 1 Simplified Block Diagram

Chassis Overview

The CTC156/157 and the CTC158/159 chassis contain five major sections. These major functional areas are:

1. Power Supply
2. System Control/Tuning
3. Signal Processing
4. Deflection Output
5. Audio Output

Throughout this manual many test points will be shown in the block diagrams and simplified schematics. These test points can be located using the test point location guides located at the back of this manual.

Power Supply

The power supply area contains two functional subcircuit areas. These subcircuits are the standby power section and the B+ regulator section. Deflection produced power supplies are not included in this section since those supplies are generated only when the horizontal deflection circuits are operating. The power supply section is protected by fuse F4001. F4001 is a 5-amp fuse located in the AC line input. All AC power to the chassis is interrupted when the fuse is opened.

Standby Power

The standby power section is responsible for standby power rectification and regulation. The AC input is applied to the standby transformer T4601. The output of the transformer is rectified and becomes the 20V standby supply. The 20V supply is used to supply the horizontal driver transformer during startup. The 20V supply is routed to 12V standby regulator Q4161. The 12V standby supply is used by the front panel assembly to supply power to the IR receiver and the keyboard scan matrix. The 12V standby supply is also routed to the on/off switch Q4162 and to the 5V standby regulator Q4160. The on/off switch is controlled by the system control microcomputer. When the switch is on, power is applied to the CTV processing IC U1001. The 5V standby regulator supplies power for the system control microcomputer and the AIU IC. These circuits must be on whenever AC power is applied to detect when the front panel power button is pressed or when the remote power on command is received.

The CTC156/157 chassis is used in both hot and cold chassis versions. The cold chassis is used in monitor versions where there are jacks for connecting to other equipment. The hot chassis is used when there are no connections to other devices. In the hot chassis version, the standby transformer is replaced by a diode and a dropping resistor. The same standby supplies are used in both the hot and cold chassis versions.

B+ Regulator

The CTC156/157 and the CTC158/159 chassis have returned to an SCR regulator system. The circuit provides a stable B+ supply for the horizontal deflection circuit regardless of variations in input voltage or changes in the load. The regulator control circuit monitors the Reg B+ output to control the turn on time of the SCR. The turn off time of the SCR is controlled by the horizontal deflection circuit. A winding in the high voltage transformer is used to provide a negative pulse to the anode of the SCR during horizontal retrace. The pulse is used to turn the SCR off. The regulator cannot operate if the horizontal deflection circuit fails to operate.

The regulated B+ output is 126V for 26″ and 27″ instruments and 129V for 20″ instruments. These levels are the same for both the CTC156/157 and the CTC158/159.

The regulator control circuit receives power from the raw B+ input. The 150V raw B+ is passed through a dropping resistor, and a 33-volt Zener diode is used to regulate the voltage for the regulator control circuit. The regulator control circuit controls the turn on time of the SCR. The control circuit is similar to the regulator control circuit first used in the CTC85 chassis. The circuit has been modified and now includes an oscillator circuit. The oscillator provides the first turn on pulse for the SCR when the set is turned on. The regulator is on whenever AC power is applied. However, the reg B+ has no load on it until the horizontal deflection circuit is operating.

The regulator control circuit and the horizontal output circuit are referenced to hot ground. Hot to cold ground isolation is provided by the standby transformer, the high voltage transformer, the horizontal yoke, and the pin cushion transformer (in 27″ instruments).

System Control/Tuning

The digital control system remains basically unchanged from the CTC140 chassis. The control system consists of the system control microcomputer U3100, analog interface unit U3300, band switching IC U3600, and the front panel controls and remote receiver. Unlike the CTC140, the CTC156/7 and the CTC158/159 do not

use a EEPROM. The system control microcomputer contains enough memory for all functions of these chassis and the EEPROM is not needed.

System control microcomputer U3100 scans the front panel keys and monitors for a key press whenever AC power is applied. When a key press is detected, U3100 determines which key is pressed and initiates the appropriate program sequence for that key press.

A serial data bus carries communications between the microcomputer and the AIU. A 4-MHz crystal controls the clock for timing the system control microcomputer and the AIU. The system control microcomputer generates the serial data bus 125-kHz clock signal by dividing the 4-MHz clock signal. Information transmitted on the serial data bus includes:

- Local and remote function commands
- AIU initialization commands
- Tuning commands

The AIU initialization data is transmitted from the microcomputer to the AIU when AC power is first applied to the set. The initialization data determines how the AIU functions. The same AIU IC is used in the CTC140, CTC145/146, CTC148/149, CTC156/157, and the CTC158/159 chassis.

The set is turned on when the AIU supplies a low to the base of PNP transistor Q4162. When the low is removed, the set is turned off. Q4162 supplies 6.8 volts to the deflection circuits in the CTV processing IC U1001. When the deflection circuits are on, the remainder of the set comes on. When the deflection circuits are turned off, the remainder of the chassis is turned off.

Control of the picture and audio is also accomplished by the AIU. The AIU supplies pulses that are filtered to create DC control voltages. The DC control voltages are then applied to the audio and video circuits. As the number of pulses varies, the DC control voltage also varies. More information concerning the digital control system can be found in the system control section of this manual.

On-Screen Display

The on-screen display is controlled by AIU generated control signals applied to the video processing circuits. The video processing circuits use the control signals to turn the picture tube guns on and off, generating the on-screen display. The on-screen display signal is mixed with the luminance signal in the CTV processing IC U1001 in the CTC158/159 chassis. In the CTC156/157 chassis, the on-screen display control signal is applied directly to the green gun of the picture tube.

Tuning

The AIU controls the tuning operation. The system control microcomputer sends the channel information to the AIU via the serial data bus. The AIU supplies band switching information to op amp/band switch IC U3600. The AIU monitors a feedback signal that represents the frequency of the tuner local oscillator. This feedback signal is referred to as FLO/K (or Frequency of the Local Oscillator divided by a constant K). By monitoring this signal, the AIU determines whether the tuning voltage needs to be increased or decreased to shift the tuner to the proper frequency. The tuning voltage is varied by sending phase pulses to U3600. The AIU also generates prescaler control pulses to change the division ratio of the feedback signal. The feedback signal has to be kept within a predetermined range in order to be processed by the AIU. The prescaler control signal changes the division ratio of the prescaler. The prescaler divides the frequency of the local oscillator to provide frequency information to the AIU.

The IF output of the tuner is routed to a SAW filter. The SAW filter provides the properly shaped output signal to the IF/video detector circuits in U1001. The IF/video detector circuit provides the AFT (Automatic Fine Tuning) signal to the AFT and the AGC (Automatic Gain Control) signal to the tuner. The AFT signal is used by the AIU to determine when the tuner is tuned to an active channel and tuned to the proper frequency. The AGC signal is used by the tuner to increase the gain of the tuner when tuning weak signals.

Audio Processing
There are many different models using the CTC156/157 and the CTC158/159 chassis. The audio circuits range from mono to stereo with a 5W per channel output. The audio processing portions of the two chassis families are different but still very similar to previous chassis.

Video Processing
The baseband video signal from the video detector is passed through a 4.5MHz trap to remove any sound IF carrier from the video signal. The video signal is then routed to the luminance and chrominance processing circuits of U1001. U1001 produces separate R-Y, G-Y, B-Y, and Y outputs which are routed to the CRT socket board. The luminance signal is added to the color difference signal to drive the guns of the CRT. There are some differences in the video processing circuits between the chassis families. The CTC158/159 chassis uses a comb filter to separate the luminance and chrominance signals, while an LC filter is used in the CTC156/157 chassis. While both chassis are used in monitor models, only the CTC158/159 is supplied with an S-video input.

Deflection Operation
U1001 contains the sync separator circuit as well as the horizontal and vertical countdown circuits. The vertical countdown circuit supplies a reset pulse to begin the start of vertical retrace. The vertical deflection circuit consists of three transistors and the vertical output device U4501. U4501 provides the drive signal for the vertical yoke. The three transistors are used to develop the drive signal for the output device.

The horizontal countdown circuit provides a horizontal drive signal. The signal is passed through a buffer stage to protect U1001. The signal is then routed to the horizontal driver and horizontal output stage. The horizontal output transistor drives both the primary of the high voltage transformer and the horizontal yoke. U1001 also contains the X-ray protection circuit.

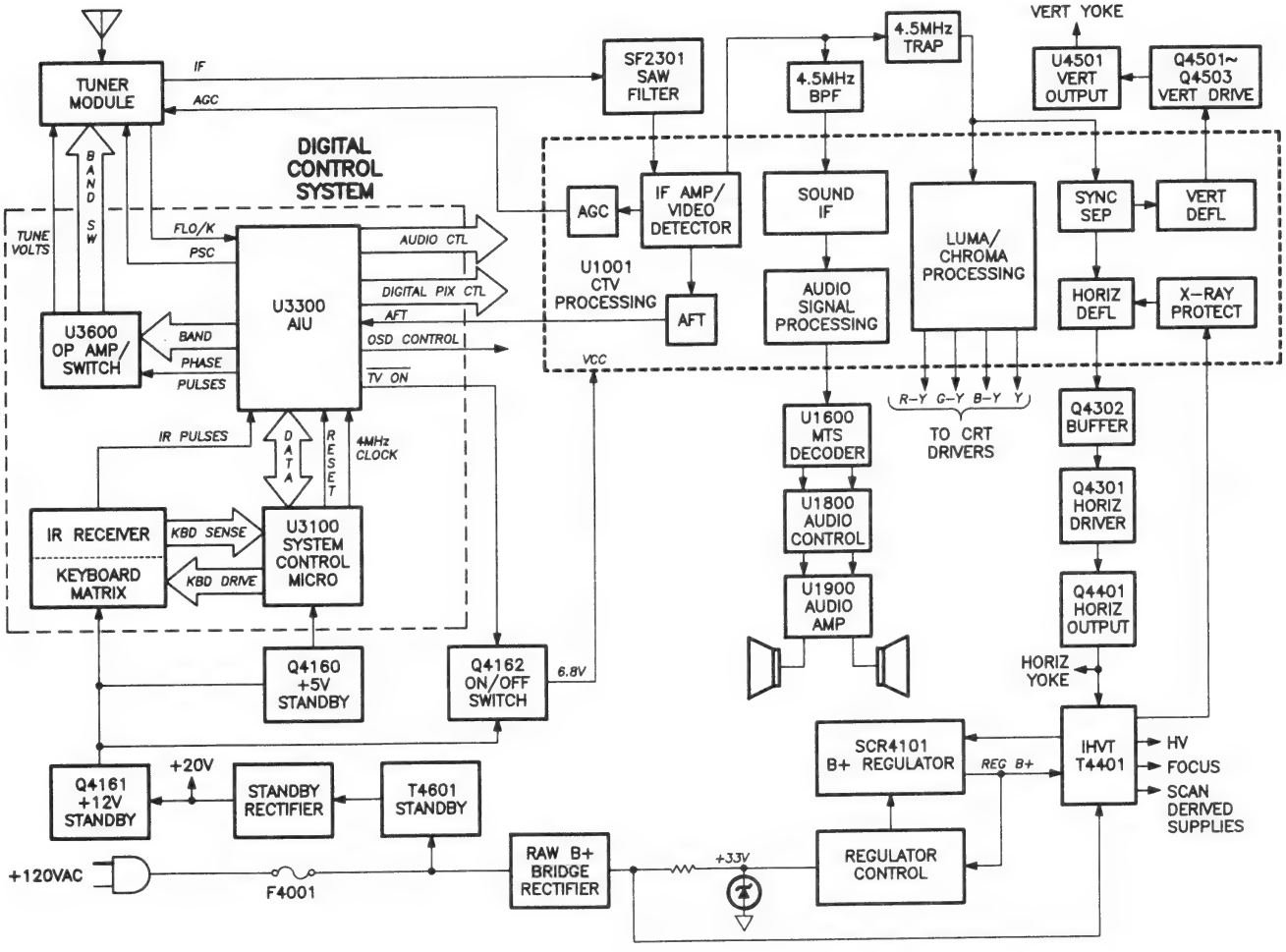


Fig. 1 Simplified Block Diagram (repeated)

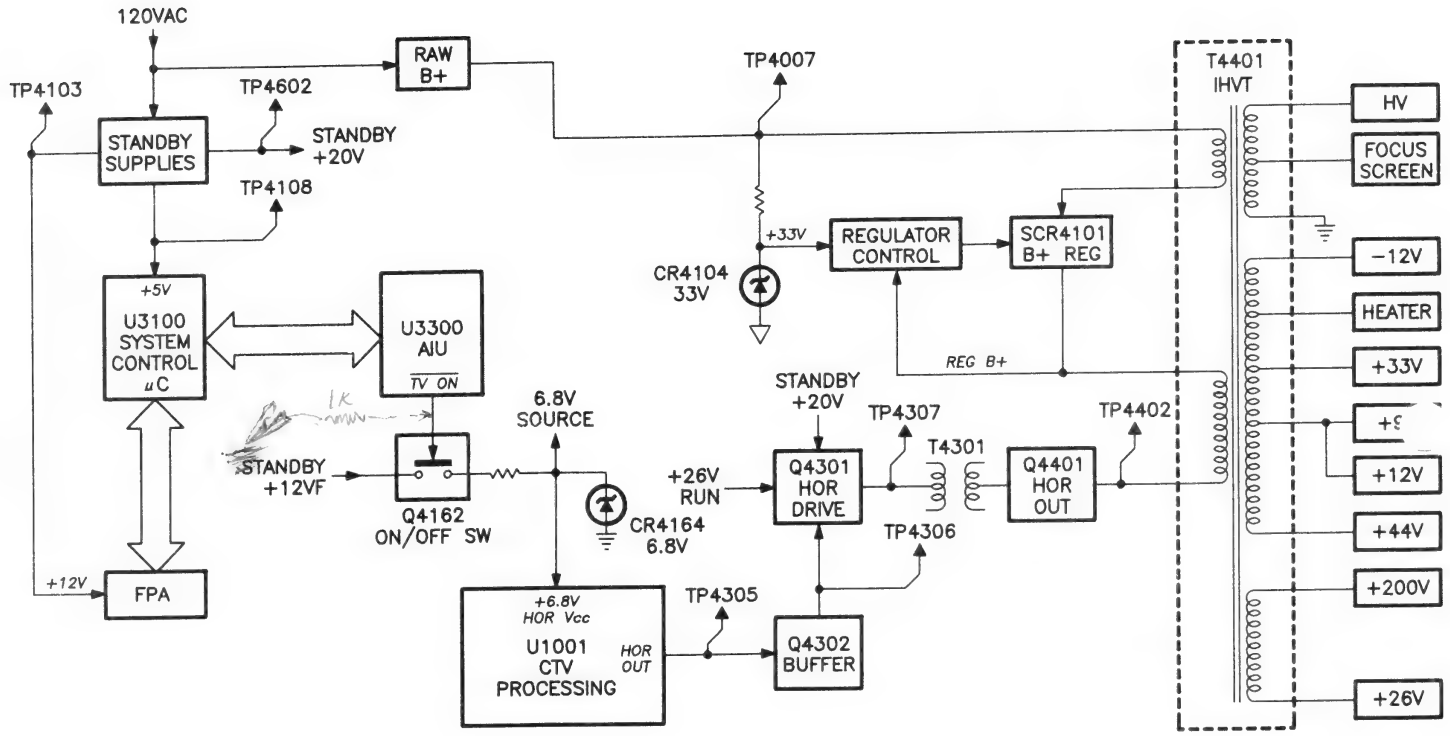


Fig. 2 Startup/Deflection/Regulator Block Diagram

Overview

The startup, deflection, and regulator circuits are needed to turn the set on. A malfunction in any of the circuit areas can result in a dead set symptom. While the system control circuit is also needed for normal operation of the instrument, this section of the manual presents a method of bypassing the system control circuit to help localize the malfunction.

The startup circuit consists of the Raw B+, standby supplies, and the TV ON signal from the AIU IC. The standby supplies provide power for the system control microcomputer, the AIU, and the front panel keyboard and remote receiver. These circuit areas must be operational whenever AC power is applied in order to detect when the customer is trying to turn the set on. The startup circuit is used to turn on the deflection and regulator circuits. The horizontal deflection circuit produces the scan-derived supplies. The remainder of the chassis receives power from these supplies.

The regulator circuit controls the operation of SCR4101. The SCR acts as a switch. When the SCR is on, the 150V raw B+ is connected to the reg B+ supply. The SCR is turned off by a negative pulse from the high voltage transformer. The on time is varied by the regulator control circuit, while the off time is determined by horizontal retrace. The Reg B+ is filtered so that the voltage supplied to the horizontal output transistor is a constant DC voltage.

Standby Supplies and Startup

The standby supplies are developed by a standby transformer and bridge rectifier circuit. The standby supplies include 5 volts to the system control microcomputer and AIU, 12 volts to the front panel assembly and on/off switch, and 20 volts to the horizontal driver transistor. These supplies are present whenever AC power is applied. The 120V AC input is also rectified to become the 150V raw B+ supply. The raw B+ is applied through the turn off winding of the high voltage transformer to the anode of the SCR. The raw B+ is also passed through a dropping resistor. A Zener diode regulates the voltage to provide power to the regulator control circuit. The regulator control circuit contains an oscillator circuit which is operating whenever power is applied. The oscillator ensures that the SCR turns on when the set is turned on. When the set is off, there is no load on the reg B+ line, and so the SCR does not latch on.

When the front panel power button is pressed, the system control microcomputer detects the keypress and relays the command to the AIU over a serial data bus. The AIU provides the $\overline{\text{TV ON}}$ signal. This signal is applied to the base of on/off switch Q4162. The transistor turns on and the 12V standby supply is routed through a dropping resistor and Zener diode. This voltage is then applied to the CTV processing IC U1001. The deflection portion of U1001 begins to operate.

The horizontal drive output of U1001 is passed through buffer transistor Q4302. The buffer output is applied to horizontal driver transistor Q4301. The output of the driver is used to drive the horizontal driver transformer. The transformer provides the base current needed to turn the horizontal output transistor on. The driver transistor receives power from the 20V standby supply during startup. Once the deflection system is operational, the 26V run supply provides power to the circuit.

When the horizontal drive pulse is coupled to the base of the horizontal output transistor, the transistor turns on, and current flows through the primary of the high voltage transformer. The SCR regulator begins to operate since the Reg B+ supply is now providing current. The SCR is turned on by the oscillator circuit contained in the regulator control circuit. The SCR is turned off when the horizontal circuit provides a large enough pulse to reverse bias the anode of the SCR.

After a few cycles, the scan derived supplies are at the rated voltages. The regulator control circuit monitors a sample of the reg B+ to keep the reg B+ voltage constant regardless of variations in the load or input voltage.

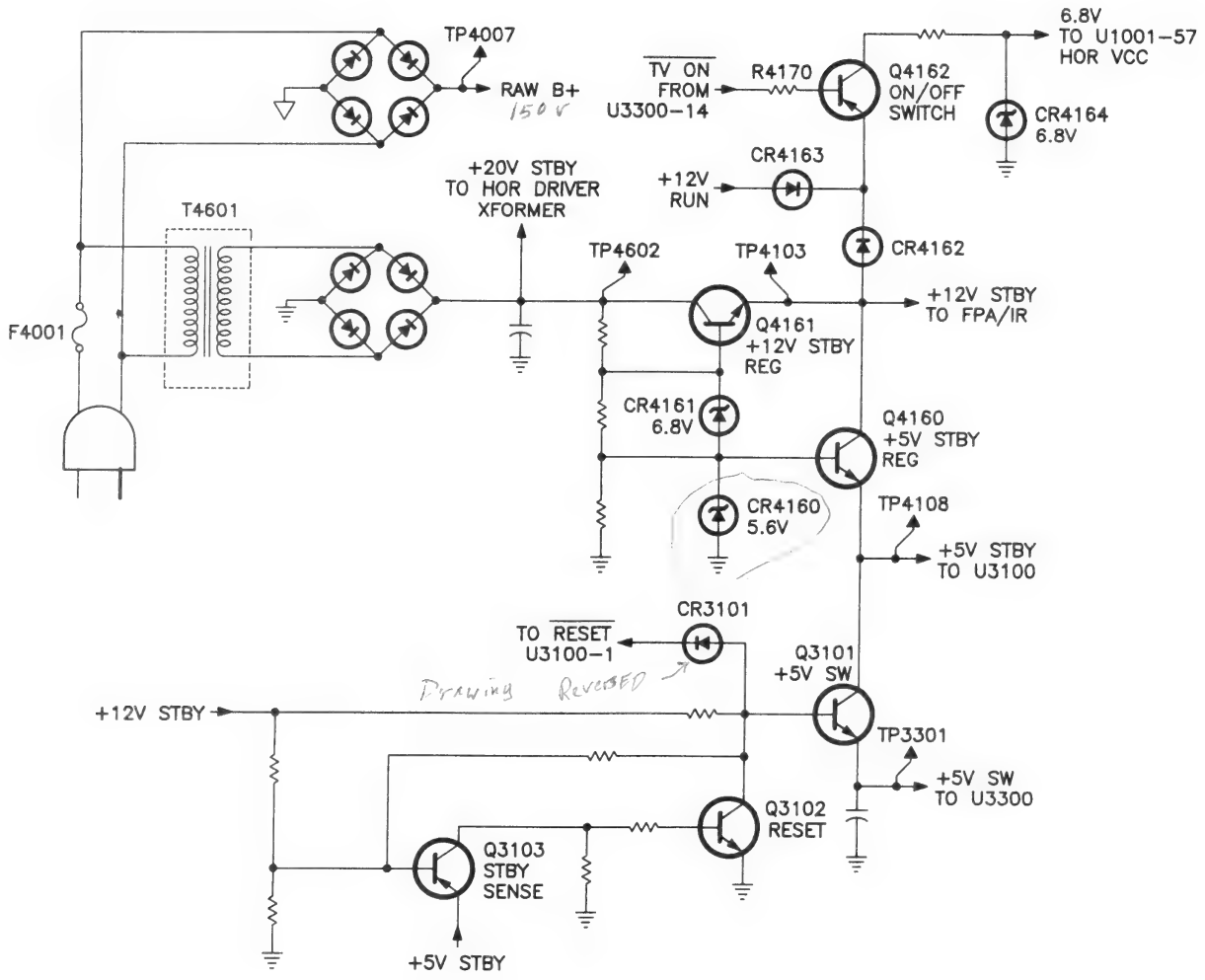


Fig. 3 Startup Circuit

Startup Circuit Operation

The startup circuit contains all of the standby supplies and control circuits to turn the set on. The system control circuit is on whenever AC power is applied. The set is turned on by supplying power to the horizontal deflection portion of the CTV processing IC U1001. When the deflection circuit is operating, all scan derived supplies are present and the remainder of the chassis becomes operational.

The AC input is routed to the standby transformer and to a bridge rectifier. The rectifier output is the raw B+ and is routed to the SCR B+ regulator circuit. The output of the standby transformer is rectified to develop the 20V standby supply. All other standby voltages are derived from the 20V supply. In addition, the 20V supply is routed to the horizontal driver transformer to provide a startup supply for the horizontal circuit.

The supply for the horizontal driver circuit is needed because these chassis are used in both hot and cold chassis versions. In the cold chassis versions of these chassis, the horizontal output stage is referenced to hot ground, while the horizontal driver is referenced to cold ground. The horizontal driver transistor needs a supply voltage before it can supply a signal to turn the horizontal output transistor on. The scan derived supplies are only present when the horizontal circuit is operating, and the horizontal circuit cannot operate without a supply for the horizontal driver transistor. The standby 20V supply provides the startup voltage for the horizontal driver transistor. When the scan derived supplies are present, diodes route the 26V run supply to the horizontal driver and the standby supply is not used.

The standby 20V supply is routed to the 12V standby regulator Q4161. The Zener diodes in the base circuit of Q4161 provide the voltage regulation. The 12V standby supply is routed to the front panel assembly. The supply provides power for both the keyboard scan circuit and the remote receiver. These circuits must remain operational whenever AC power is applied to be able to detect when the set is supposed to turn on.

The 12V standby supply is routed through diode CR4162 to on/off switch Q4162. The on/off switch is controlled by an output from the AIU IC. When Q4162 is on, the 12V supply is routed through a dropping resistor to the horizontal deflection portion of U1001. The TV is turned on by starting the horizontal deflection circuit. Zener diode CR4164 regulates the input voltage to the horizontal portion of U1001. When the horizontal circuit is operating and the scan derived supplies are present, the 12V run supply provides the power to the on/off switch through CR4163. The 12V run supply is a slightly higher voltage than the 12V standby supply, and CR4162 becomes reversed biased.

The 12V standby supply is also routed to the 5V standby regulator. Q4160 provides power to the B+ input of the system control microcomputer. The 5V standby supply is also routed to 5V switch Q3101. The 5V switch supply provides power for the AIU. The 5V switch supply is present whenever AC power is applied. The supply is switched off whenever there is a loss of AC power. The purpose of the switch is to reduce the load on the 5V standby supply during a loss of AC power. The 5V standby supply charges a capacitor providing the memory backup. Turning Q3101 off during a loss of AC power reduces the load on the memory backup capacitor and increases the memory retention. The 5V switched supply is controlled by Q3102 and Q3103. Standby sense transistor Q3103 detects the loss of the standby supplies, indicating a loss of AC power. When the 12V standby supply drops below 9 volts, Q3102 is turned on. When Q3102 is on, the reset line to the system control microcomputer is pulled Lo and 5V switch transistor Q3101 is turned off. The reset line remains Lo until the 12V standby supply rises above 9.5V. The minimum memory retention time is 10 seconds, but typically the time is between one and five minutes.

Troubleshooting Strategies

Most malfunctions in the startup circuit result in a dead set symptom. Malfunctions in the system control, B+ regulator, and horizontal deflection circuits can also produce a dead set symptom.

1. If the startup circuit is suspected of causing the dead set symptom, begin by confirming the presence of the 20-volt standby supply at the collector of Q4161. If the voltage is missing, check the fuse, standby transformer and rectifier diodes.
2. If the 20-volt supply is present, check for the 12-volt standby supply at the emitter of Q4161. If the 12-volt supply is missing, check for 12 volts at the base of Q4161. If the voltage is present at the base, suspect a short circuit in a component supplied by the 12-volt standby supply. If the voltage is missing at the base, suspect CR4160 and CR4162.
3. If the 12-volt standby supply is present, confirm the presence of the 5-volt standby supply at the emitter of Q3101. If the voltage is missing, suspect Q4160 or Q3101.
4. If the 5-volt standby supply is correct, check for the 150-volt raw B+ supply at TP4007. If the voltage is missing, check CR4001 through CR4004 and R4101.
5. If the raw B+ supply is correct, check to see that the reg B+ supply is approximately the same as the raw B+ supply when the set is off. If it is not, suspect R4113.
6. If the raw and reg B+ supplies are the same, check for a triangle waveform at the collector of Q4103. If the waveform is missing, suspect the regulator control circuit. If the waveform is present, suspect the SCR, or the horizontal deflection circuit.

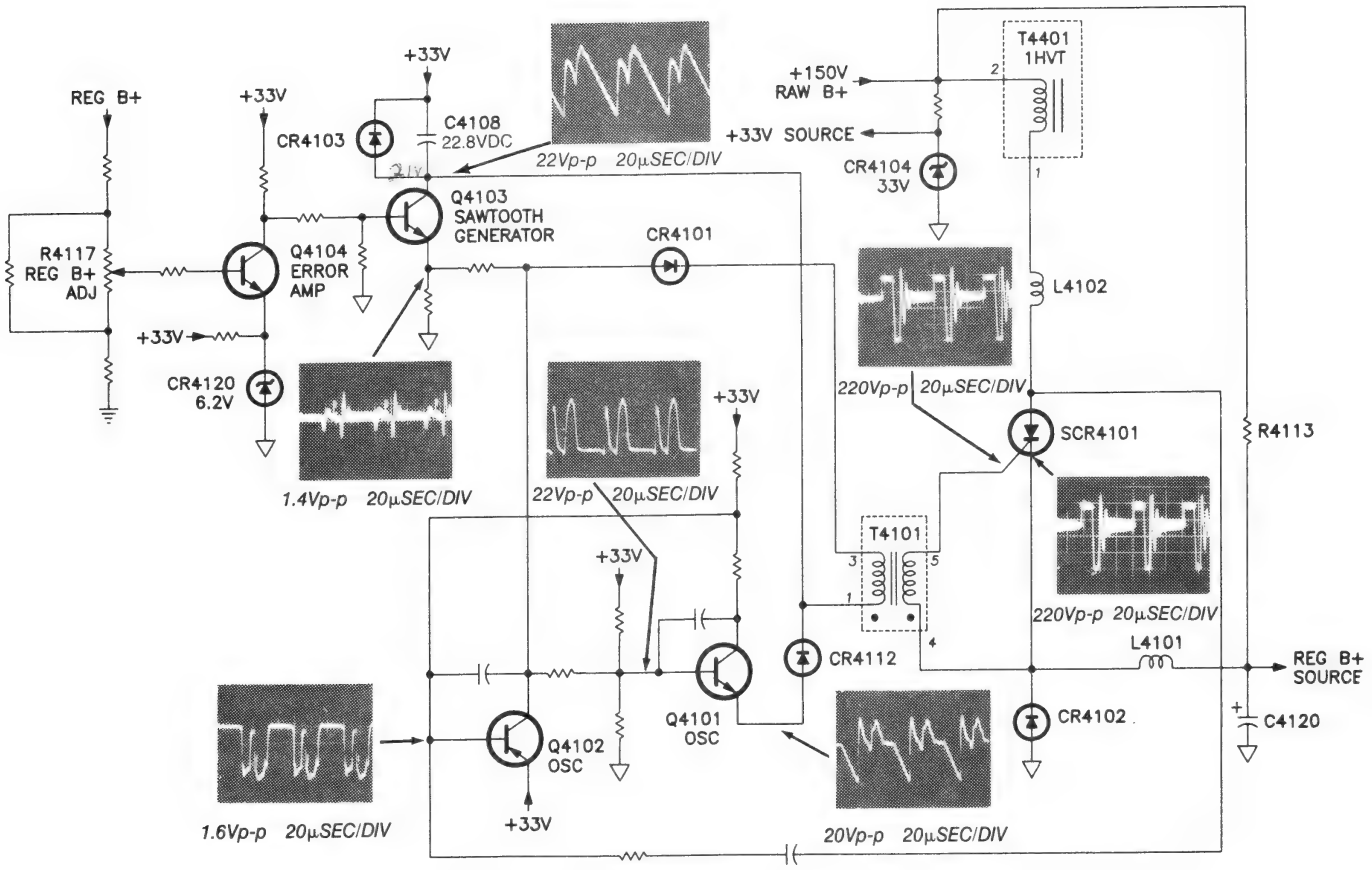


Fig. 4 B+ Regulator Circuit (TV On)

B+ Regulator Circuit Operation

The regulator control circuit is similar to the circuit first used in the CTC85 chassis. The circuit turns the SCR on at the correct time to keep the Reg B+ supply at the proper level. The control circuit operates whenever AC power is applied. During standby or power off operation, the regulator oscillator operates continuously as a free running oscillator. In the run mode, the regulator oscillator is synchronized to horizontal.

During the run mode, the regulated B+ is divided by a resistor network and compared to a fixed reference voltage. The resulting error signal controls the turn on time of the SCR. The length of time that the SCR conducts determines the amount of energy stored in the system during each horizontal line. The SCR is turned off by a negative pulse from the IHVT. This pulse occurs during horizontal retrace. During the power off mode, the regulator oscillator is free running. However, there is a very small load on the reg B+ line, and so the SCR does not latch on, even though gating pulses are applied to the gate.

Standby (Power Off) Operation

During standby or power off operation the regulator oscillator operates continuously as a free running oscillator. The oscillator generates a sawtooth at the collector of Q4103. When AC power is applied, the 33V supply is present. The resistor divider network at the base of Q4103 biases the transistor on. C4108 begins to charge. As C4108 charges, the voltage at the collector of Q4103 decreases. When the voltage reaches the lower trip point of approximately 9.1 volts, Q4101 begins to conduct. As Q4101 conducts, the voltage at the base of Q4102 decreases, causing it to go into saturation. With Q4102 in saturation, CR4101 is forward biased, creating a discharge path for C4108. The 33 volts at the emitter of Q4102 is routed through the transistor, CR4101, and the primary of SCR driver transformer T4101 to the low side of C4108. This surge of energy produces a pulse of current which turns the SCR on. Q4101 and Q4102 continue to conduct until Q4103 reaches the high trip point. The high trip point is determined by the resistor network at the base of Q4101. Q4101 continues to conduct until the voltage at the low side of C4108 causes CR4112 to become reverse biased. When Q4101 turns off, the voltage at the base of Q4102 rises, causing it to turn off. When Q4102 turns off, Q4103 is able to turn on, and the process is repeated.

In the standby mode there is little load on the reg B+. The voltage difference across the SCR is not enough to cause the SCR to latch on. When the SCR does not conduct, the load on the reg B+ would cause the reg B+ to slowly decrease until it reached a point where the SCR would latch on. When the SCR turned on, a rush of current would go through L4101 to charge C4120. This current could cause an audible noise in L4101. A resistor is placed between raw B+ and reg B+ to bias the cathode of the SCR at a point where it can not turn on in the standby mode.

Run Mode Operation

In the run mode, the regulator control circuit operates in much the same way as in the standby mode. The difference is that the oscillator is now synchronized to the horizontal. A negative going retrace pulse is developed in the high voltage transformer regulator winding. This pulse turns the SCR off and is also coupled to the base of Q4102. The pulse at the base of Q4102 causes it to go into saturation and quickly discharges C4108. When Q4102 turns off, C4108 resumes its normal charging sequence until the lower trip voltage is reached. Discharging C4108 during horizontal retrace ensures that the regulator begins at the same point on each horizontal line. The SCR turn on time is determined by error amplifier Q4104.

The regulated B+ supply is sensed through a resistor divider network at the base of Q4104. The base of the transistor is the inverting input of the error amplifier. The emitter (or non-inverting input) of the transistor is held at a constant voltage determined Zener diode CR4120. The voltage at the collector of Q4104 is determined by the variations in the base bias voltage. The voltage at the base changes proportionately with changes in the reg B+ voltage. For example, if the reg B+ voltage rose, the voltage at the base of Q4104 would increase. The voltage at the collector of Q4104 would decrease, causing Q4103 to conduct less. This would tend to increase the charge time of C4108 and increase the turn on time of the SCR. Since the SCR turns on later and the turn off time is fixed, there is less energy available to charge reg B+ capacitor C4120. Conversely, a decrease in the reg B+ input would cause the voltage at the base of Q4103 to rise, causing Q4103 to conduct more. C4108 charges sooner and the SCR is turned on earlier. The regulator operates by changing the slope of the sawtooth waveform at the collector of Q4103.

Diode CR4103 is a clamp to keep the reset level of C4108 the same for every cycle. CR4112 protects the base emitter junction of Q4101 when C4108 is charged to 33 volts.

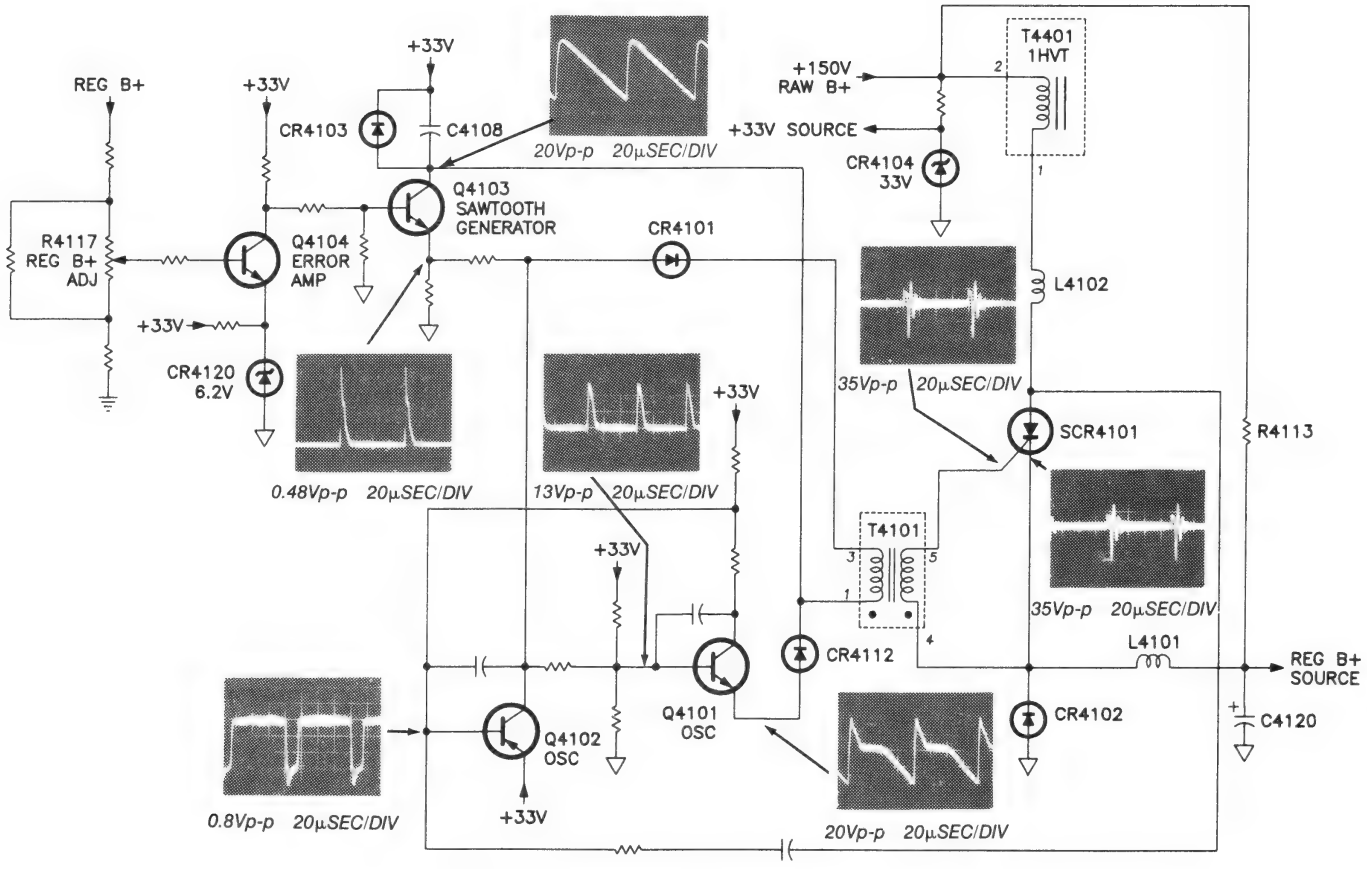


Fig. 5 B+ Regulator Circuit (TV Off)

Troubleshooting Strategy
Malfunctions in the regulator circuit can cause symptoms as varied as a dead set to bends in the picture. All malfunctions can be divided into just two categories, regardless of the symptom. The first type is the dead set. In this case, the regulator never turns the SCR on, and consequently reg B+ is never generated. The second type is the regulator operates but does not regulate properly. In this case the reg B+ voltage will be either too high or too low, but the troubleshooting procedure remains the same.

Dead Set (SCR does not turn on)
A dead set symptom can be caused by a number of circuit areas. For example, the system control microcomputer might not detect when the power button is pressed or a malfunction in U1001 might prevent the horizontal deflection circuit from operating. If the regulator control circuit is suspected of causing the dead set symptom, begin by confirming that both the raw B+ and 33 volt supplies are present. Both supplies are referenced to hot ground. If the 33 volt supply is missing or incorrect, suspect Zener diode CR4104.

1. After confirming that the raw B+ and 33 volt supplies are correct, check for an SCR turn on pulse at the gate of the SCR. These pulses are present whenever AC power is applied and should be checked with the TV in the standby mode. The pulses are approximately 35Vp-p and occur just slightly slower than horizontal rate. If the pulses are present, the regulator is probably functioning normally. It is possible that the SCR is defective, however the malfunction is more likely to be in the startup circuit. Refer to the startup operation section of this manual for troubleshooting procedures for the system control and the horizontal deflection startup circuits.
2. If the SCR turn on pulses are missing at the gate of the SCR, check for a sawtooth waveform at the collector of Q4103. The signal at this point is a sawtooth that decreases from the 33 volt supply down to about 9 volts. If the sawtooth waveform is present, suspect a defective transformer T4101. If the sawtooth is missing, measure the DC voltage at the collector of Q4103.
3. If the voltage at the collector of Q4103 is approximately 33 volts, suspect a shorted CR4103, defective Q4101 or Q4102, or a malfunction in the base bias circuit of Q4103.
4. If the voltage at the collector of Q4103 is less than 9 volts, suspect an open CR4101 or CR4112, or a defective Q4102.
5. If a sawtooth is present at the collector of Q4103 but the amplitude or frequency is incorrect, suspect a leaky CR4120 or defective Q4104.

Regulator Operates Incorrectly
If the regulator operates incorrectly, the reg B+ supply voltage will either be too high or too low. Malfunctions can cause raster distortion or lines in the picture. In addition, if the reg B+ supply increases too high, the XRP circuit can cause the set to shut down. Since problems in the horizontal circuit or the scan derived supplies can affect the reg B+ supply, it is necessary to confirm proper operation of the horizontal circuit before troubleshooting the regulator circuit.

To bypass the regulator circuit and force the horizontal circuit to operate, remove AC power. Connect a 1k Ohm resistor from the base of on/off switch Q4162 to cold ground. Connect a jumper between pin 2 and pin 12 of the high voltage transformer. Connect the AC line cord to a variable isolation transformer and slowly increase the AC input until the set begins to operate (about 80VAC). The horizontal deflection circuit should operate, but the raster will be blank since the rest of the chassis is not operating. If the set operates with the raw and reg B+ supplies jumpered, the problem is most likely to be in the regulator control circuit. If the set still does not operate or shuts down immediately, the problem is in the horizontal deflection circuit.

1. If the horizontal circuit operates normally with the regulator circuit bypassed, begin troubleshooting the regulator by measuring the DC voltage at the base of Q4104. The voltage at the base should be approximately 0.6V higher than the voltage at the emitter, or 6.8V. If the voltage is incorrect, suspect a leaky or shorted CR4120, or an open or shorted resistor in the reg B+ adjust resistor divider network.
2. If the voltage at the base of Q4104 is correct, measure the DC voltage at the collector of Q4104 with the set off and on. There is approximately 10 volts at the collector when the set is off and about 6 volts when the set is on. If the voltage at the collector does not change when the set is turned on, suspect a defective Q4104. If the voltage is correct at the collector of Q4104, but the regulator still operates incorrectly, suspect an open or shorted resistor in the base circuit of Q4103.

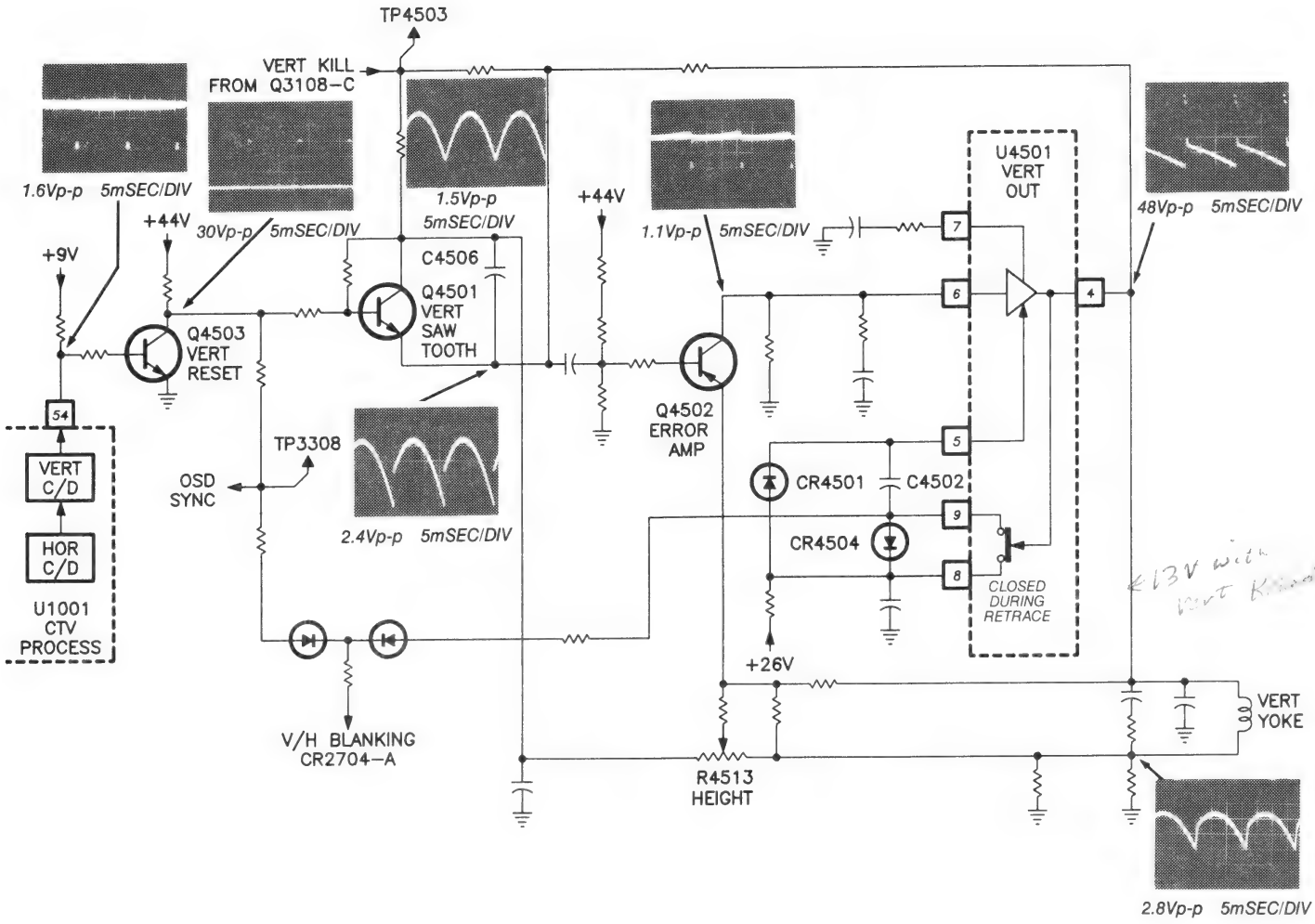


Fig. 6 Vertical Deflection Circuit

When replacing U4501
New Part may be 8 pin or 10 Pin

Vertical Deflection Circuit Operation

The vertical deflection circuit develops a ramp of current through the yoke to scan the electron beam down the face of the picture tube. The circuit configuration is similar to that used in the CTC140 chassis.

Active components of the vertical circuit are the CTV processing IC U1001, vertical reset transistor Q4503, sawtooth generator Q4501, error amplifier Q4502, and vertical output U4501. U1001 and Q4503 provide the reset pulse to initiate vertical retrace. Q4501 quickly discharges the sawtooth capacitor during the retrace interval. Q4502 amplifies the vertical drive signal and supplies it to the vertical output IC. U4501 contains both the top and bottom power output devices and a boost switch to increase the peak voltage supplied to the output stage during retrace.

Vertical Scan Operation

To scan the beam down the picture tube, the current through the yoke must change direction. Current flows from U4501 pin 4 during the top half of trace and into pin 4 during the bottom half of trace. Current through the yoke is zero when the beam is at the center of the screen and maximum when the beam is at the top or bottom. The current must also change direction during retrace.

When the TV is turned on, the system control circuit keeps the vertical circuit off until degaussing is complete. The vertical kill signal from the collector of Q3108 defeats the vertical drive signal for approximately 2.5 seconds when the set is first turned on. The vertical kill signal is also used to collapse the scan when the service line is displayed. While the scan is collapsed, the DC feedback through the height control adjustment causes the output voltage at pin 4 of U4501 to stabilize at approximately half of the supply voltage (about 12 volts).

Scan begins following the turn off of the sawtooth transistor Q4501. Sawtooth capacitor C4506 begins to charge. The downward sloping ramp is capacitively coupled to the base of the error amplifier Q4502. Q4502 develops an error signal at the collector which causes U4501 to supply current into the yoke. Current continues to flow until the feedback voltage at the emitter of Q4502 is equal to the base voltage. The output current ramp is made to track the signal at the base of the error amplifier.

Vertical Retrace Operation

Vertical retrace is started by CTV processing IC U1001. The vertical countdown circuit accurately divides the signal from the 32fH oscillator to produce a vertical rate signal. The vertical sync signal starts retrace at the correct time. U1001 develops a negative going pulse to turn off vertical reset transistor Q4503. When Q4503 turns off, the voltage at the collector increases, causing Q4501 to turn on. When Q4501 is on, the sawtooth capacitor is discharged quickly. The rapid discharge produces a positive going pulse that is coupled to the base of Q4502. Q4502 turns off, and the input at pin 6 of U4501 drops to 0 volts. The vertical output stage is an inverting amplifier, and so the low input drives the output to maximum.

When the retrace pulse is generated by U1001, the voltage at pin 4 of U4501 is at a minimum. The current through the yoke is at a maximum, flowing through the yoke into pin 4. At the start of retrace, the voltage at pin 4 increases to about 26 volts. Because the yoke current cannot instantly change direction, current continues to flow from the yoke into pin 4. The voltage at pin 4 rises above the 26-volt supply. The level detector senses the increase and opens the boost switch to increase the output stage supply to 50 volts. This allows the voltage at pin 4 to rise to 50 volts. As the field collapses in the yoke, the yoke current decrease to zero, and the bean is moved up to the center of the screen. Yoke current begins to flow in the opposite direction, and the increased output voltage from the IC causes the beam to move rapidly to the top of the screen. When the feedback voltage increase to the point where it equals the sawtooth reference voltage, the error signal from Q4502 causes the voltage at pin 4 to drop below the 26-volt supply. The level detector again senses the change and closes the boost switch, and vertical scan begins at the top of the screen.

Boost Switch Operation

The boost switch increases the supply voltage to the vertical output circuit during retrace to quickly move the beam from the bottom to the top of the screen. During vertical trace, the boost switch is open and 26 volts is supplied through CR4501 to the vertical output stage of U4501. During trace, C4502 charges to 26 volts with respect to ground.

The boost switch is controlled by the level detector contained in U4501. The level detector determines when the output voltage at pin 4 is greater than the supply voltage at pin 8. This condition is caused by the retrace current from the yoke. When the boost switch closes, and the

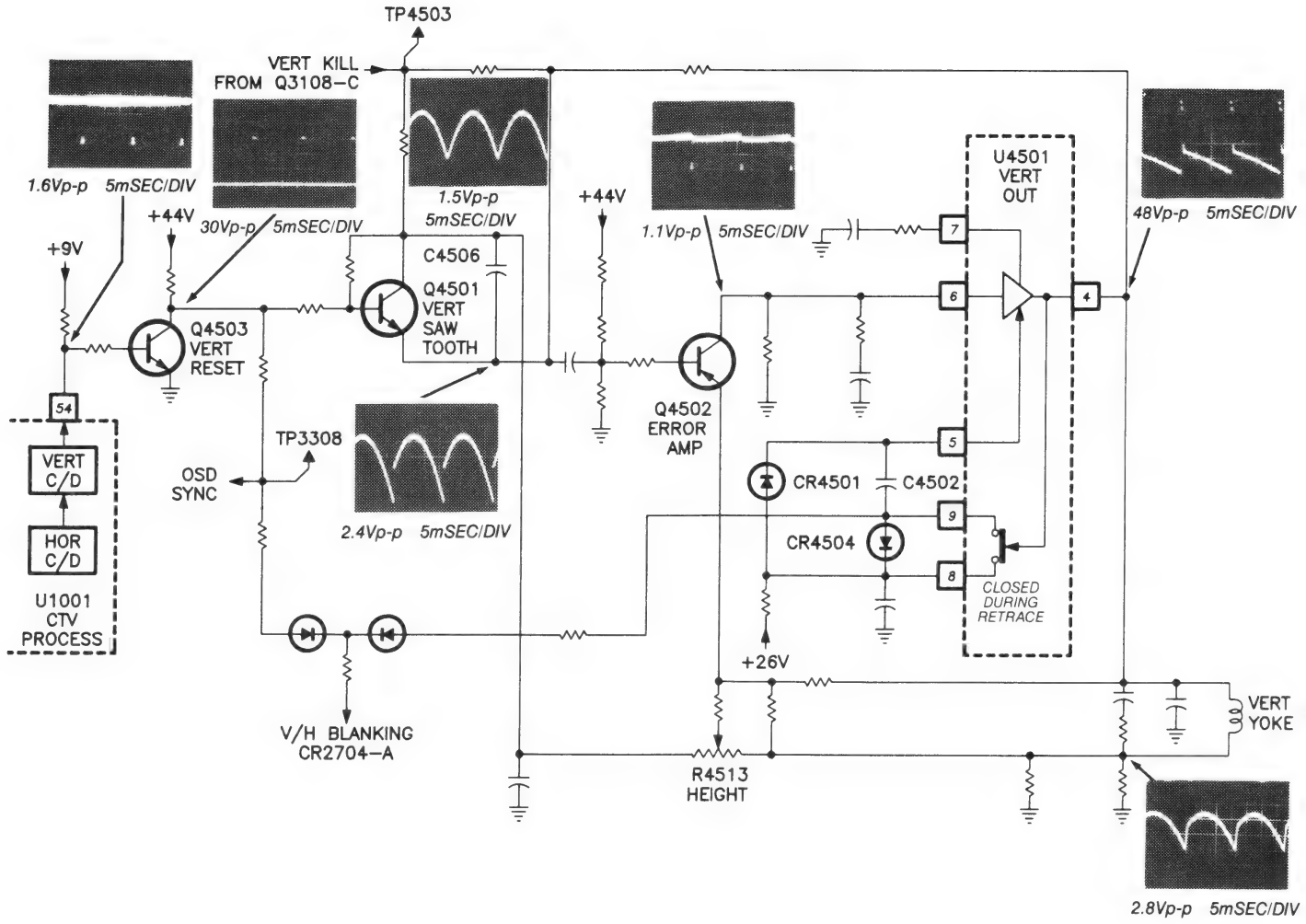


Fig. 6 Vertical Deflection Circuit (repeated)

26-volt supply is applied to the negative side of C4502 through pin 9. Because C4502 was charged to 26 volts during trace, the voltage from pin 9 is added to this voltage and 52 volts is supplied to the vertical output stage. At the same time, CR4501 becomes reverse biased, and prevents the 52 volts from affecting the 26-volt supply. The boost switch opens at the beginning of vertical trace. The time that the boost switch is closed is determined by the retrace voltage, the peak yoke current, and the yoke inductance and is not adjustable.

Vertical Circuit Troubleshooting

The majority of failures of the vertical circuit result in a no vertical scan symptom. The first step in confirming the operation of the vertical circuit is to check the DC operation. It is advisable to defeat the scan in order to prevent a malfunction in the AC portion of the circuit from affecting the DC operation.

Note: To defeat the scan (obtain the service line) hold the SETUP button in while plugging in the AC power cord. Pressing any front panel button restores normal operation.

The power amplifier in U4501 along with the error amplifier Q4502 can be viewed as an operational amplifier with the non-inverting input at the base of the error amplifier and the inverting input at the emitter. The error voltage at U4501 pin 6 drives the voltage at pin 4 and the voltage at the emitter of Q4502 to equal the 13 volt reference at the base of Q4502. Proper DC operation can be confirmed by checking the DC voltage at the output of U4501 pin 4 and the emitter of Q4502. The voltage should be 13±1 volts DC.

Note: Do not replace the vertical IC for improper DC operation unless pin 4 is near 26 volts and pin 6 is above 1.1VDC, or when pin 4 is near 0 volts, pin 6 is less than 0.9 volts and pin 5 is 24-27VDC.

If the DC operation of the vertical circuit is correct, press any of the front panel buttons to cancel the service line. Measure the DC voltage at U4501 pin 4. If the voltage is approximately 13 volts, check for 0.6Vp-p reset pulses at U1001 pin 54.

- If the pulses are missing, suspect U1001, or the resistors in the base circuit of Q4503.
- If the pulses are present, suspect a malfunction in Q4503 and associated components.

If the voltage at U4501 pin 4 is less than 2VDC, check the DC voltage at the vertical kill output of the system control microcomputer U3100 pin 6. The signal should be Hi during normal operation. If the signal is Lo, suspect a malfunction in the system control circuit. If the voltage is Hi, confirm proper operation of vertical kill transistor Q3108. When this transistor is on, it provides the DC return path for the low side of the vertical yoke. When the transistor is off, the vertical deflection circuit is defeated.

- If the vertical kill circuit is operating normally, check the DC voltage at the cathode of CR4501. If the voltage is approximately 25 volts, suspect U4501. If the voltage is less than 20 volts, suspect an open CR4501 or a malfunction in the 26-volt supply.

If the voltage at U4501 pin 4 is greater than 20 volts, check the voltage a the emitter of Q4502. If this voltage is less than 20 volts, confirm that the vertical yoke is connected.

- If the voltage at the emitter is greater than 20 volts, check the DC voltage at the collector of Q4502. If the voltage is greater than 1.1 volts, suspect U4501. If the voltage is less than 0.9 volts, suspect Q4502, Q4501 and associated components.

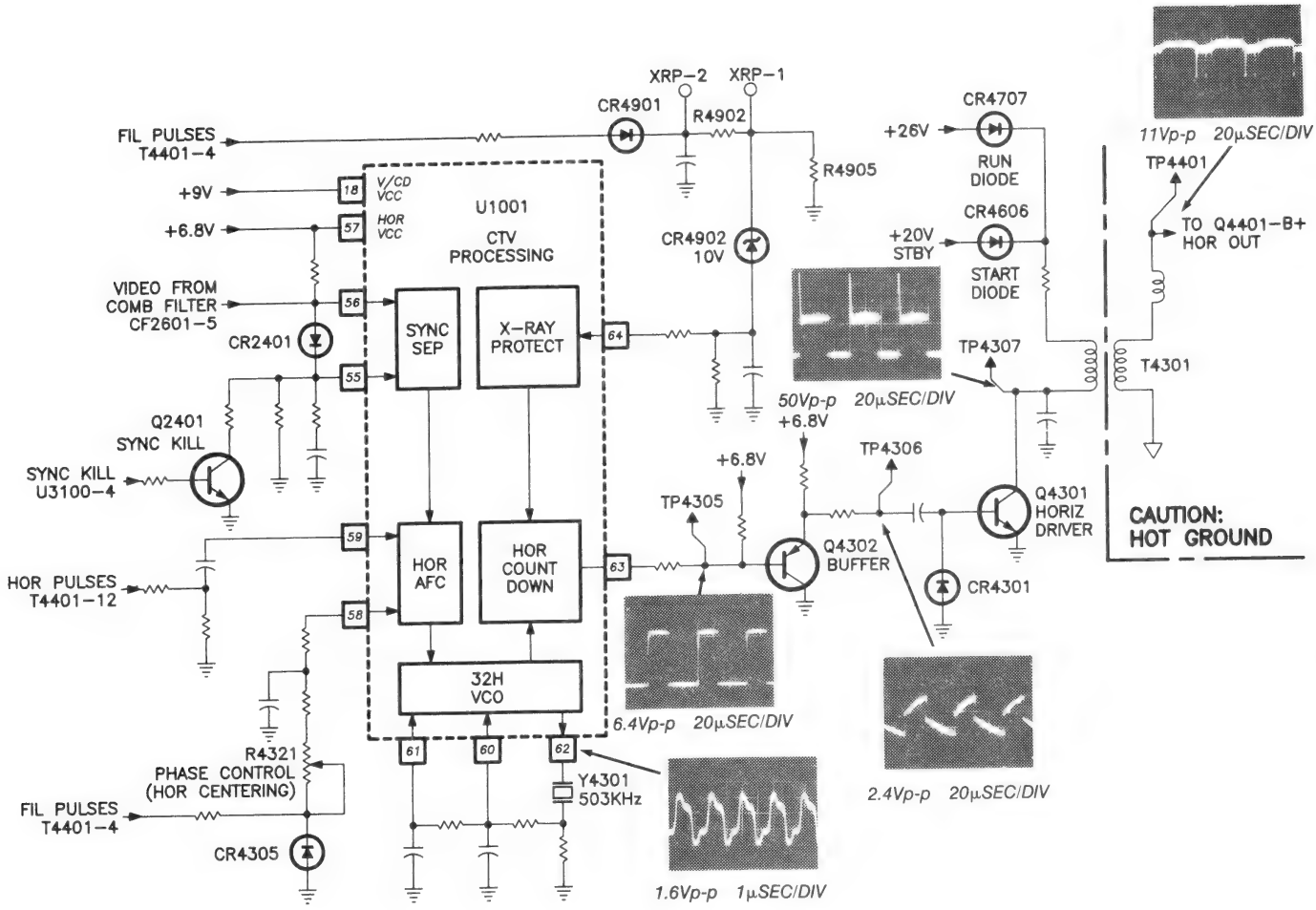


Fig. 7 Horizontal Drive Circuit

Horizontal Drive Circuit Operation

The circuit configuration of the horizontal drive circuit is similar to the design used in the CTC145/146 chassis family. U1001 contains the horizontal countdown circuit and generates the drive signal for the horizontal driver transistor. The output of U1001 is passed through a buffer stage before it is applied to the base of the horizontal driver transistor. The output of the horizontal driver is transformer coupled to the base of the horizontal output transistor. The output of the horizontal output transistor drives both the high voltage transformer and the horizontal yoke.

The video signal from the comb filter is applied to the sync separator circuit in U1001. The sync kill signal from the system control microcomputer is applied to the base of Q2401. When Q2401 is on, the RC time constant network at U1001-55 is grounded and pin 56 is grounded through CR2401. This allows the horizontal circuit to free run, providing stable on-screen display during channel changes and auto-programming. When the sync kill circuit is off, the horizontal sync signal is applied to the horizontal automatic frequency control (AFC) circuit.

The AFC circuit compares the output of the horizontal circuit to the occurrance of horizontal sync. A sample of the horizontal output pulse is supplied from pin 4 of the high voltage transformer to an integrator circuit. The output of the integrator is a sawtooth waveform. The sawtooth is compared to a fixed reference voltage. The output of the AFC circuit is a DC control voltage applied to the 32fH voltage controlled oscillator. The AFC circuit output modifies the signal from the VCO to phase lock the horizontal deflection frequency to the incoming sync signal. The horizontal phase control changes the time constant of the integrator, changing the slope of the sawtooth applied to the AFC circuit. An increase in the slope moves the video to the left of the raster and a decrease in the slope moves the video to the right. An additional sample of the horizontal output pulse is applied to the AFC loop filter in U1001 to compensate for horizontal scan size changes caused by variations in the scene brightness.

The frequency of the horizontal oscillator is determined by crystal resonator Y4301. The output of the crystal is 32 times the horizontal frequency (503 kHz). The output of the VCO circuit is applied to the horizontal countdown circuit. The countdown circuit divides the 503-kHz signal to the proper frequency for the horizontal deflection circuit (15,734 Hz). The horizontal drive output of the countdown circuit is amplified and exits U1001 at pin 63.

The output signal from U1001 is applied to the base of buffer transistor Q4302. The buffer transistor was added to reduce the current demand on U1001. The 6.8V supply is used for the base drive of Q4301 to avoid reverse biasing U1001 when the set is off. The output of the buffer is applied to the horizontal driver Q4301. The output of the horizontal driver is transformer coupled to the base of the horizontal output transistor. The power for the driver stage is supplied from the 20V standby supply during startup and by the 26V run supply during normal operation.

The horizontal drive signal is coupled through horizontal driver transformer T4301 to the base of the horizontal output device Q4401. The output at the collector of Q4401 drives the primary of the high voltage transformer and the horizontal yoke windings. The secondaries of the high voltage transformer develop a variety of outputs that are used to power various circuits within the chassis.

The 6.8V supply input to U1001 is the power source for the horizontal deflection and the X-ray protection stages of U1001. The 9V input is the power source for the video processing, chroma processing, vertical deflection, and deflection sync separator portions of U1001. The 9V supply is not used by the horizontal deflection portion of U1001.

X-Ray Protection

One of the windings of T4401 is used to closely track the high voltage supply. The pulses at pin 4 of T4401 are rectified by CR4901, charging the capacitor. A rise in the high voltage causes arise in the detected voltage. The detected voltage is applied to a precision resistor divider network. The voltage at the junction of R4902 and R4905 is then applied to the cathode of Zener diode CR4902.

CR4902 is a 10-volt Zener diode. The XRP threshold, at the anode of CR4902, is about 13.5 volts (10 volts for CR4902 and 3.5 volts for U1001). The normal operating voltage for pin 64 of U1001 is about 1.9 volts. This voltage varies as beam current changes.

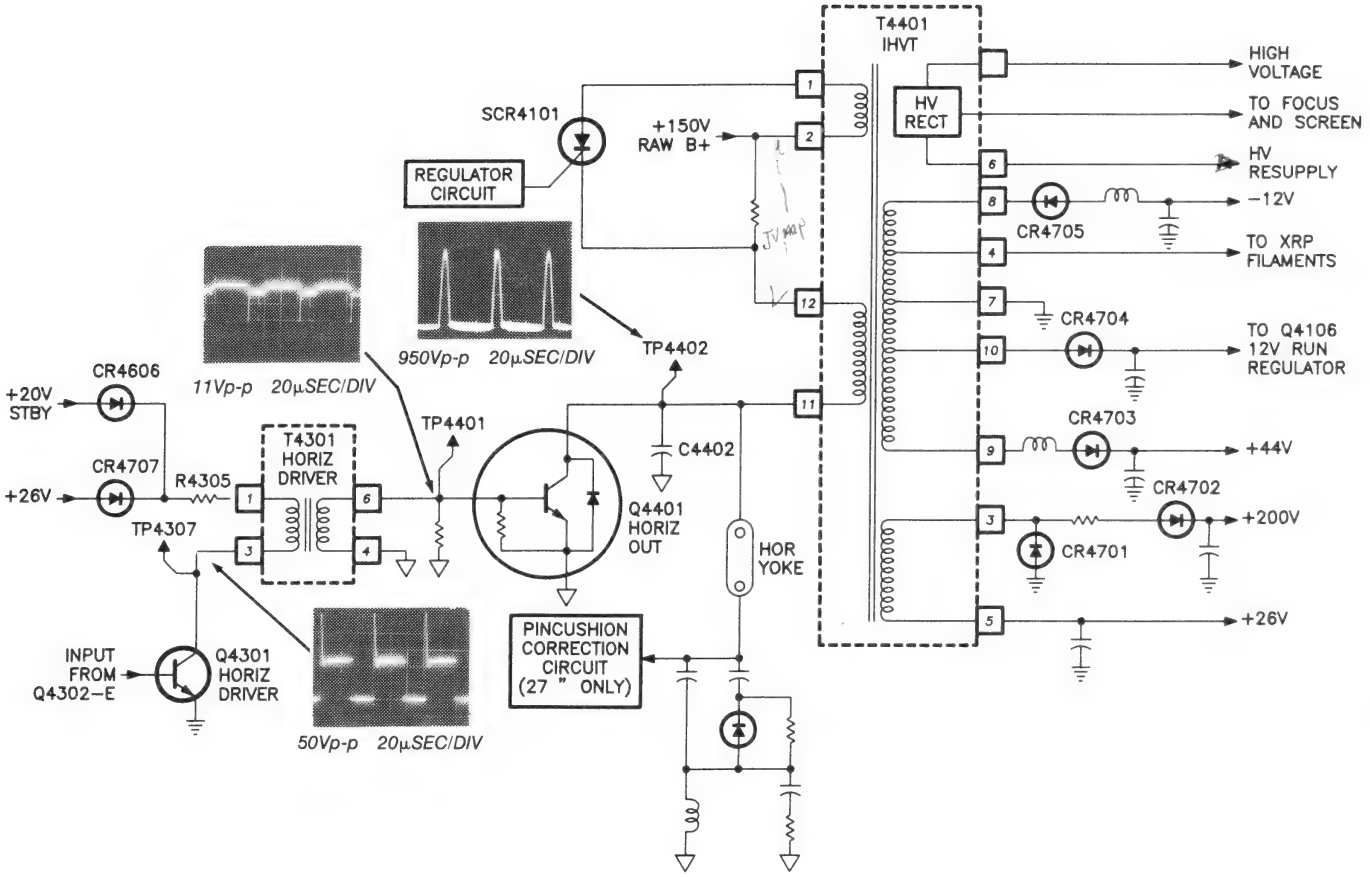


Fig. 8 Horizontal Output Circuit

When the XRP threshold is exceeded, the X-ray protection circuit is activated. The horizontal output circuit in U1001 is disabled. This is a latching circuit and will not allow the set to restart as long as the 6.8 volt supply is present at U1001. However, the X-ray protection input of the system control microcomputer detects the loss of the 9 volt supply when the horizontal circuit stops operation. The system control microcomputer then causes the on/off switch Q4162 to cycle on and off.

The X-ray protection circuit is activated when the voltage at pin 64 rises above 3.5 volts. This prevents the production of the horizontal drive pulses and the chassis run supplies. The X-ray detection port of the system control microcomputer detects the loss of the run supplies and directs the AIU to turn the on/off switch off. About two seconds later, the system control microcomputer provides the on command, waits about 0.25 seconds, and checks for the 9 volt supply at the X-ray protection port (U3100-36). If the 9 volt supply is missing, the on/off cycle is repeated until the fault is corrected. If the 9 volt supply is present, the set resumes normal operation.

Shutdown Troubleshooting
Any malfunction which prevents the production of the 9 volt run supply causes the system control microcomputer to shut the chassis down. In addition, faults in the system control circuits or the 9V run supply sensing network at the XRP DET port of the system control microcomputer can cause the same symptoms. Some of the faults that can cause the cycling-shutdown symptom are:

- Activation of the X-ray protection circuit
- Loss of the 9 volt run supply
- 9V run supply sensing network problems
- Loss/low voltage of raw/reg B+
- Horizontal drive/output problems
- High voltage transformer problems
- Standby supply problems
- Defective microcomputer

It is necessary to force the operation of the horizontal deflection circuit in order to more easily diagnose shutdown problems. By forcing the operation of the horizontal circuits, the deflection circuit can be isolated from the system control circuit. The technique allows the chassis to run long enough to locate the malfunction. Without this technique, troubleshooting shutdown symptoms is difficult due to the cycling on and off caused by the shutdown.

Before forcing the operation of the horizontal deflection circuits, check the AC line fuse. If the fuse is open, replace it and test the chassis for normal operation. If the fuse opens again, begin troubleshooting by making resistance measurements in the power supply and horizontal output circuits. If the fuse is good, force the horizontal to operate by connecting a 1k Ohm resistor from the base of on/off switch Q4162 to *cold* ground.

When forcing the horizontal deflection circuit to operate, one of three things will happen:

1. The horizontal circuit will operate normally or appear to run normally. (Note: When the horizontal is forced to run the tuner and signal processing circuits are not operating and so the raster is blank. Check for proper operation of the horizontal circuit by measuring the run supply voltages and observing the waveform at the collector of the horizontal output transistor on an oscilloscope.)
2. The horizontal circuit runs with some difficulty.
3. The horizontal circuit will not start or shuts down quickly and may appear to have not started.

Horizontal Deflection Circuit Operates Normally
When the horizontal deflection circuit operates normally in a forced start, the malfunction is normally associated with the system control area or the loss of run supplies. Ensure that the 9V run supply is present and that at least 4.5 volts is present at pin 36 of the system control microcomputer. It is possible for this symptom to be caused by a horizontal drive problem usually associated with low voltage on the 6.8-volt supply.

If the voltage on the 6.8-volt supply is low, the horizontal deflection section of U1001 and the horizontal driver will not be properly biased. This condition causes a horizontal drive signal with low peak to peak voltage and reduces the voltage of the chassis run supplies. The horizontal deflection circuit is able to run fairly well on the reduced voltage during forced operation. However, the system control microcomputer will shut the set down during normal operation due to the reduced voltage on the 9 volt run supply.

Possible causes for the reduced voltage on the 6.8V supply include a leaky 6.8V regulator CR4164, an excessive load on the 6.8V line due to a defective component, or an excessive load on the 12V run supply.

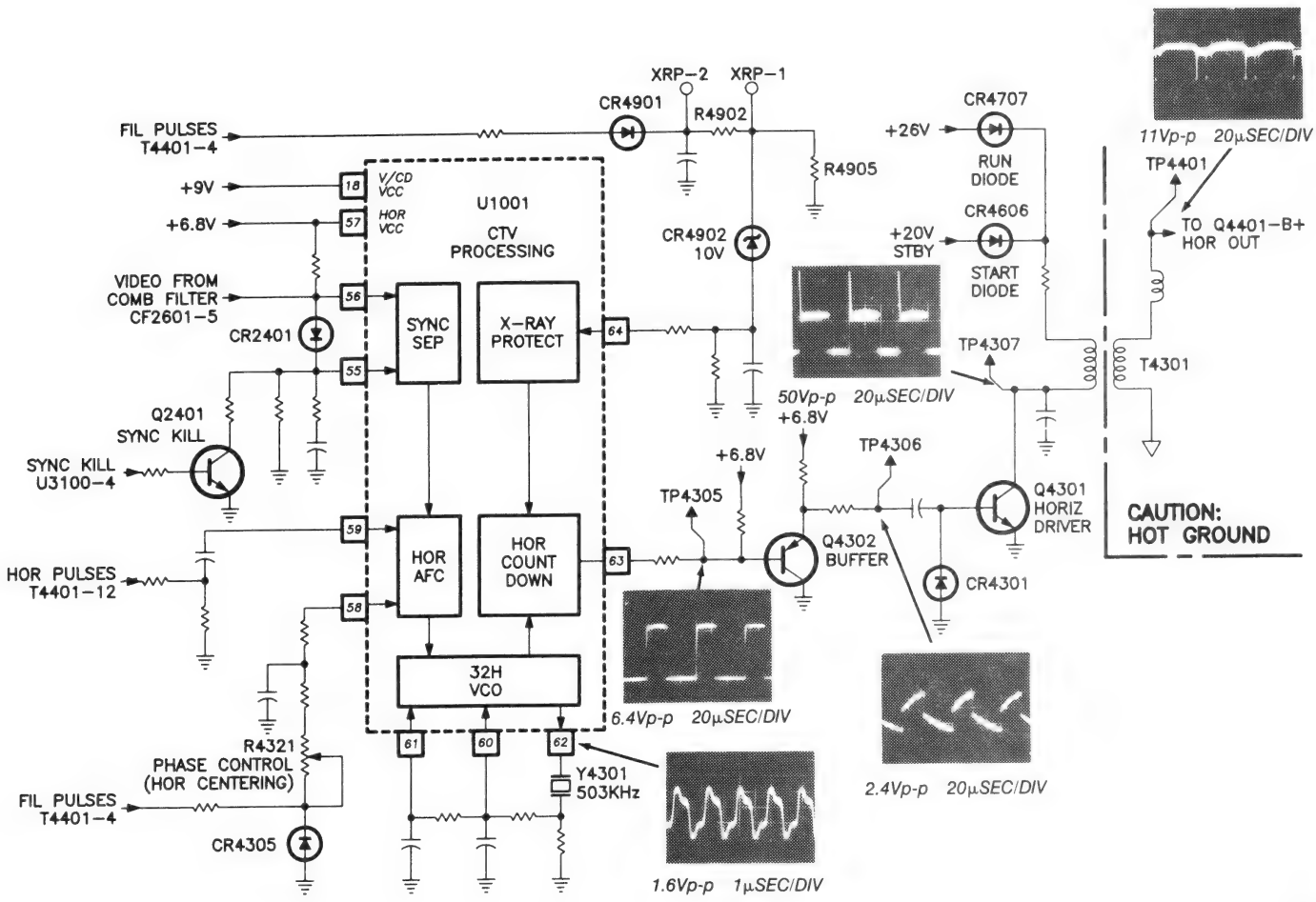


Fig. 7 Horizontal Drive Circuit (repeated)

Horizontal Circuit Operates With Difficulty

If the horizontal circuit operates with some difficulty, the problem is usually associated with a horizontal drive or output problem.

Begin by removing AC power and measure the resistance from the collector of the horizontal output transistor to ground. Note: The horizontal output transistor is referenced to hot ground, while the horizontal driver is referenced to cold ground. If the resistance is less than 500 ohms, suspect a leaky or shorted component in the horizontal output transistor collector circuit. If a very high resistance is found at the collector, reapply AC power and force operation. Confirm that the proper drive signal is present at the base of the horizontal output transistor.

If the signal is missing or incorrect, suspect U1001, Q4301, Q4302, or T4301. If the drive signal is correct, remove AC power and connect the AC power cord to an isolated AC variac or variable isolation transformer. Connect a jumper between pins 2 and 12 of the high voltage transformer to bypass the regulator circuit. While monitoring the waveform at the collector of Q4401, slowly increase the AC input until the set turns on (approximately 80VAC). It is normal for the frequency of the horizontal output pulse to be slightly unstable during forced operation because sync is not provided to the horizontal section.

If the collector of Q4401 does not produce a proper pulse, suspect a problem with Q4401, the primary circuit of T4401, or the raw B+ circuit. If a normal waveform is present at the collector, slowly raise the AC input voltage while monitoring the reg B+ voltage at TP4008, the reg B+ test point. Increase the AC input until the reg B+ reaches the proper level of 126 volts.

Monitor the waveform at the collector of Q4401 for any abnormal reactions to increasing the reg B+. If the reg B+ voltage can be raised to the normal level and the output of the horizontal output stage is normal, the horizontal deflection deflection circuit is operating normally and the malfunction is located in the regulator circuit. If the horizontal system shuts down, suspect a breakdown problem in the insulation of T4401, the XRP circuit, or XRP shutdown.

If an abnormal waveform is observed at the collector of Q4401 when AC power is increased, suspect an open retrace capacitor, an open yoke, a short on the secondary of T4401, or a short on the 6.8 volt or the 12 run supplies.

Horizontal Circuit Does Not Operate

Perform the same tests described in the previous section. If the horizontal deflection circuit fails to operate, trace the horizontal drive signal. When the horizontal output transistor does not operate, the shape of the drive signals will be somewhat different than normal. This is because the horizontal deflection circuits are not properly loaded.

When the horizontal deflection circuit shuts down as the AC line voltage is increased, suspect XRP shutdown or a defective XRP circuit. Check the components in the XRP circuit with an ohmmeter. If the XRP components are good, suspect XRP shutdown. Possible causes of XRP shutdown include: high reg B+, open retrace capacitor C4402, shorted turns in the primary of T4401, a defect in U1001, or a defect in T4401.

To confirm XRP shutdown as the cause, remove the reg B+ supply from the horizontal output transistor by unsoldering the collector of Q4401. Force operation of the horizontal circuit and check for a drive waveform at the base of Q4401 with the AC input set to provide normal reg B+ (126 volts). If the drive waveform remains stable with the full reg B+ applied, XRP shutdown is confirmed. If the drive signal is interrupted, check the signal path for the presence of the drive signal to isolate the defective stage.

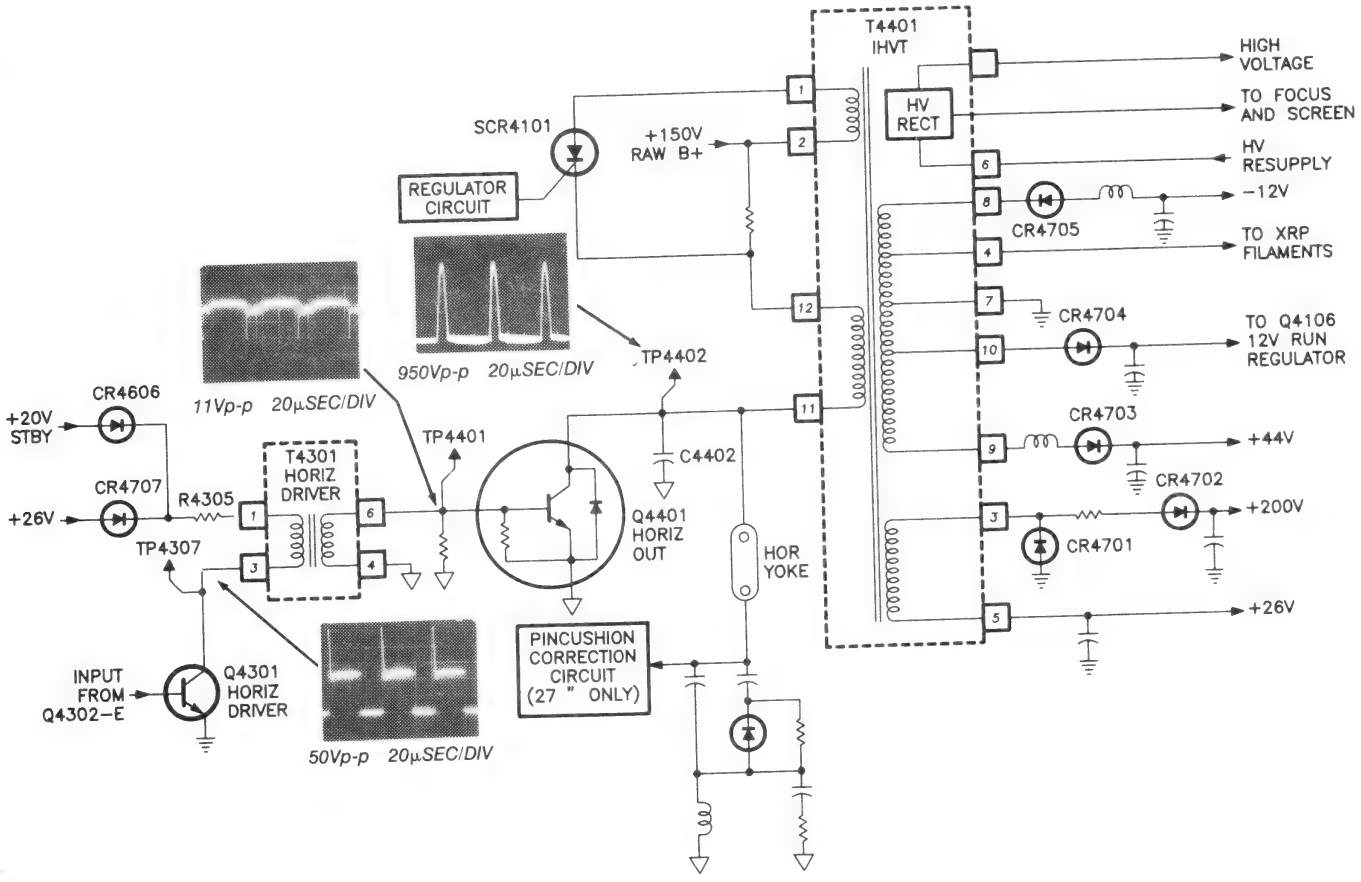


Fig. 8 Horizontal Output Circuit (repeated)

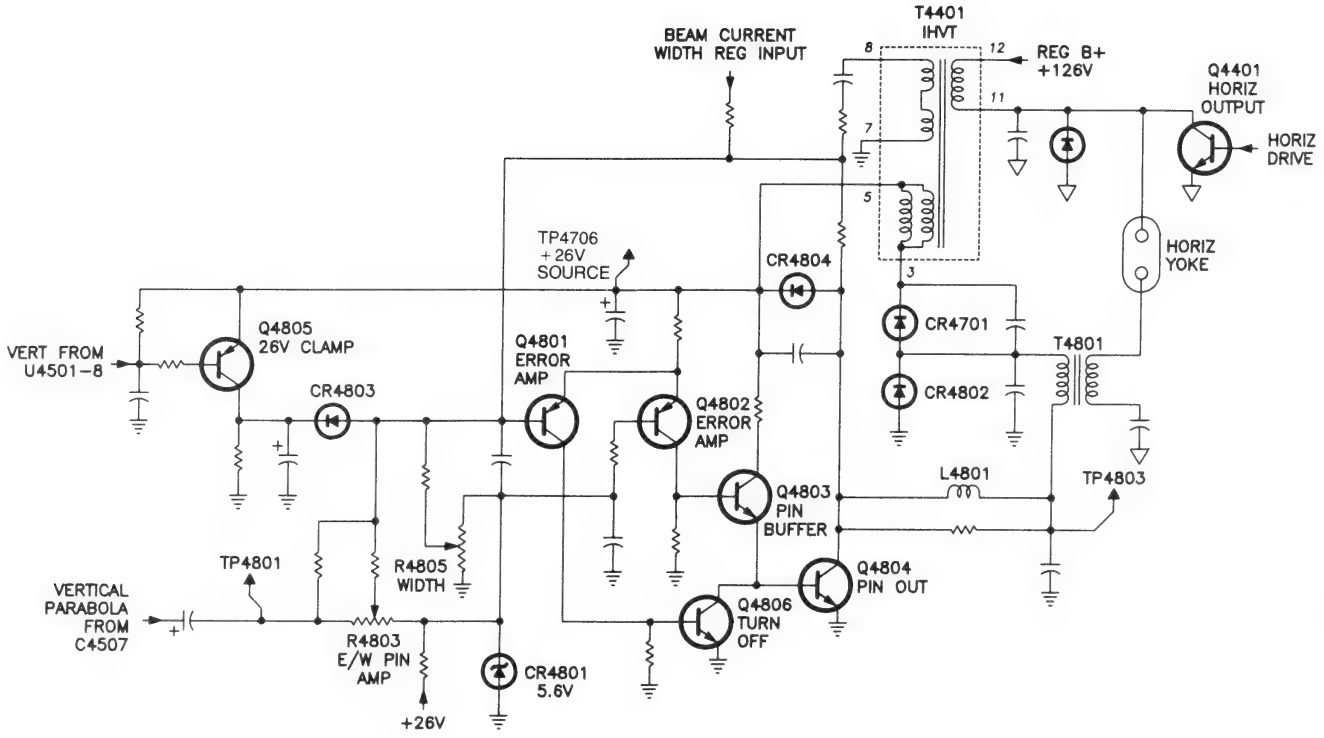


Fig. 9 Pincushion Correction Circuit

Pincushion Correction Circuit Operation

The pincushion correction circuit modulates the horizontal yoke current at a vertical rate to correct for distortions in the raster caused by the physical shape of the face of the picture tube. This correction circuit is used on 27″ models only. On the smaller screen sizes, the conventional linearity coil and pin corrected yoke provide the necessary correction.

The primary of the pin transformer T4801 is in series with the horizontal yoke. This forms an inductive voltage divider between the yoke and the pin transformer. The reg B+ supply is split between the two inductances. By modulating the current through the pin transformer, the percentage of the reg B+ appearing across the yoke changes, changing the width. The width increases as more of the reg B+ voltage appears across the yoke.

The width is varied at a vertical rate since the beam must travel further to trace a horizontal line at the top or bottom of the screen than it does at the center. The correction circuit develops a parabola waveform which is applied to the pin transformer. The input to the control circuit is a vertical parabola. The signal is applied to the base of error amplifier Q4801. East/west pin amplitude control R4803 determines how much of the vertical parabola is input to the error amplifier. Width control R4805 sets the DC operating point of the error amplifier. The beam current input to the error amplifier allows the pin correction circuit to compensate for changes in width caused by variations in the beam current. The capacitor at the base of Q4801 integrates the pulse from pin 8 of the IHVT to form a ramp.

The positive portion of the ramp at the base of Q4801 causes Q4801 to turn off during horizontal retrace. When Q4801 is off, Q4804 is turned on. Q4804 remains on until the voltage at the base of Q4801 drops below the 5.6V reference level at the base of Q4802. The on time of Q4802 determines the average current through the pin transformer. Turn off transistor Q4806 ensures that the pin output transistor turns off quickly. When the pin output transistor turns off, the energy stored in L4801 causes current to flow through CR4804 to the 26V supply.

The pin correction circuit interacts with both the 26V supply and the vertical circuit. The vertical circuit is the biggest single load on the 26V supply. If a loss of vertical scan occurs, the pin circuit could cause the 26V supply to rise above 26 volts. To prevent this condition, a pin disable circuit senses the loss of vertical scan and shuts off the pin correction circuit. A vertical signal from the vertical output IC is applied to the base of Q4805. Q4805 is turned on during the first half of vertical scan to clamp the 26V supply. When loss of vertical scan occurs, Q4805 stays off. CR4803 becomes forward biased, pulling the base of Q4801 low. This causes the horizontal scan to go to minimum and keeps the 26V supply at approximately 24 volts.

System Control Operation

The system control circuit used in the CTC156/157/158/159 family of chassis is very similar to the system control circuits used in the CTC145/146/148/149 chassis. The system control circuit of both these chassis families are based on the CTC140 chassis. CTC156/57/58/59 chassis continues to use the 40-pin System Control microcomputer U3100. An Analog Interface Unit (AIU) similar to the one used in the CTC140 and CTC145/146/148/149 chassis is also used in the CTC156/157/158/159 chassis.

A serial data bus carries communications between the System Control μC and AIU. A 4-MHz crystal controls the clock for timing the System Control μC and the AIU. The system control microcomputer generates the clock signal at pin 33 of U3100 for the serial data bus. The clock operates at 125 kHz, and is generated by internally dividing the 4-MHz clock signal. The information transmitted on the serial data bus includes:

- Local and remote function commands
- AIU initialization data
- Tuning commands.

The AIU initialization data is transmitted from U3100 to the AIU when AC power is first applied to the set. The initialization data that is output from the system control μC determines how the AIU functions. The same AIU IC is used in the CTC156/157 and CTC158/159 chassis because the functions of the AIU are determined by the initialization from the system control μC.

Most areas of system control operation are familiar to servicers that have experienced with the CTC140 and CTC145/146/148/149 chassis. Some areas of the system control operation are less familiar. These areas are detailed in the following sections.

The System Control μC has some unique pins that may be unfamiliar to some servicers. These pins are $\overline{\text{INT}}$ @ pin 2, M/$\overline{\text{S}}$ @ pin 34 and $\overline{\text{XRP DET}}$ @ pin 36. The $\overline{\text{INT}}$ (Interrupt Request) port U3100-2 is pulled high by the +5V SW supply. Pin 2 must be pulled high for the system control μC to function normally. An open or intermittent pull-up resistor (R3119) can cause unusual symptoms in the system control circuit. Before changing the System Control μC always check to see that pin 2 is pulled high.

The M/$\overline{\text{S}}$ (Master/$\overline{\text{Slave}}$) port U3100-34 is also pulled high by the +5V SW supply. Pin 34 of U3100 must be pulled high for the micro to function in the master mode. If the high at pin 34 is lost, the system control μC will enter the slave mode and wait for instructions from a master micro. An open or intermittent pull-up resistor (R3123) can cause unusual symptoms in the system control circuit. Before changing the micro always check to see that pin 34 is pulled high.

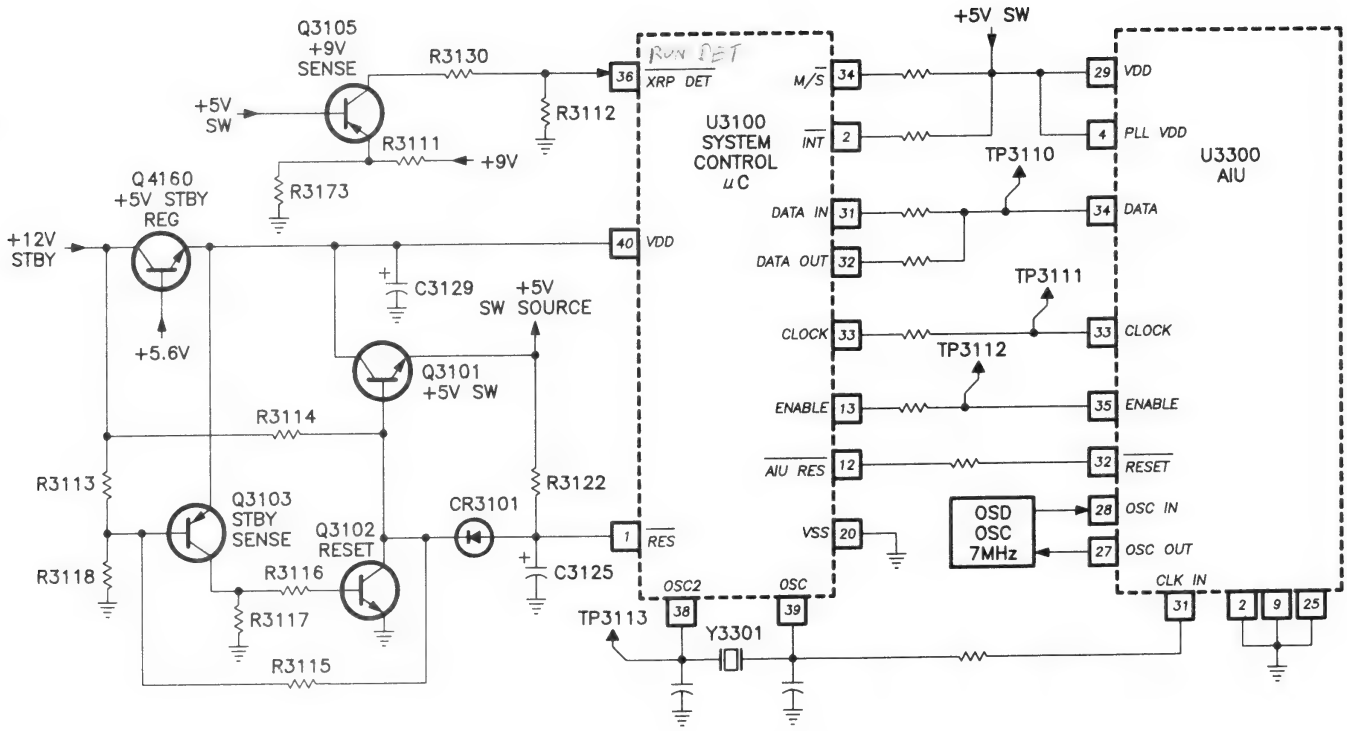
The $\overline{\text{XRP DET}}$ (X-Ray shutdown detect) port of U3100-36 is supplied with a Hi that is developed by R3130 and R3112. During normal operation, the +5V standby voltage is applied to the base of Q3105. The +9V run voltage (generated by the deflection system) is input to the emitter of Q3105. Under this condition, Q3105 is On, causing a Hi to be input at pin 36. If the deflection circuit is shutdown thus causing the +9V run voltage to disappear, Q3105 turns Off and a Lo is applied to pin 36. When pin 36 goes low, the system control circuit turns the chassis off. The system control circuit then tries to restart the chassis at two second intervals. For more information, see "System Power Control" in the chassis overview section and "Shutdown Troubleshooting" in the horizontal deflection section.

System Control Memory Functions

A basic understanding of system control memory functions is necessary in order to properly diagnose system control malfunctions. System control microcomputer U3100 contains both Random Access Memory (RAM), and Read Only Memory (ROM). CTC156/157/158/159 family of chassis chassis do not contain nonvolatile EEPROM memories, therefore memory is lost during extended power interruptions.

RAM

The RAM is used to store information which is frequently changed, such as the channel scan list, the current channel number along with other customer settings such as the current picture and volume settings. This information is used to update the AIU. Storing this information enables customer features such as; allowing the set to turn on to the last channel viewed with the same volume and picture settings as when the set was turned off.



System Control/System Reset and Communications

ROM

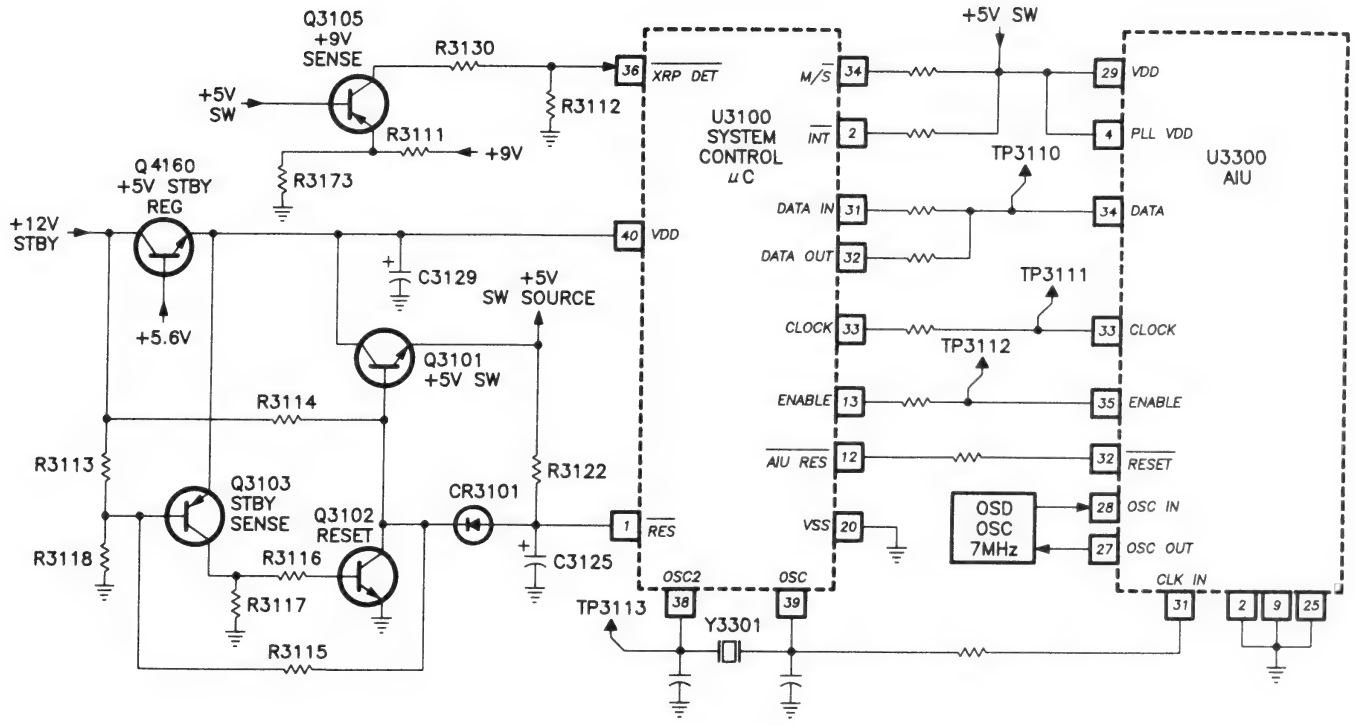
The ROM portion of memory is used to store information which is never changed, such as the programs for the microcomputer, the on screen display characters, the tuning algorithm, etc. Memory failures internal to U3100 are rare. To prevent unnecessary replacement of U3100 for a suspected memory malfunctions such as, failure to store the channel scan list during autoprogramming, memory operation may be tested as follows:

1. Connect the TV to an RF input. Turn on the TV and tune to an active channel.
2. Set the volume control to minimum.
3. Set all picture controls (color, tint, contrast, etc.) to a full scale position (high or low).
4. Use the Setup menu to select the cable or air tuning mode as needed.
5. Store or delete channels in channel memory as desired. Channels do not have to be active to be manually stored in the memory. Make a list of the channel status (stored or deleted).
6. Turn off the TV. Wait 30 seconds and turn the TV on again.
7. Check all memory settings to see if any have changed.

If the memory settings did not change, the memory is functioning normally. Therefore, the problem (failure to autoprogram, etc.) is not related to a memory malfunction. If the memory settings changed, suspect low voltage on the +5V STBY supply or a defective micro.

System Control Reset

The purpose of the reset circuit is to ensure that the microcomputer starts at the same point in its program every time the AC power is first applied. An RC network consisting of R3122 and C3125 provides a short time delay before the reset process begins. The time delay ensures that the +5V standby voltage is applied to the μC and that the 4-MHz oscillator is operating before any program steps in the microcomputer are initiated. The system control microcomputer and the AIU must be reset each time AC power is applied to the chassis.



System Control/System Reset and Communications

U3100 is also reset after power interruptions of approximately one second or longer. The reset input to the microcomputer is at pin 1. The reset occurs when the input goes from Lo to Hi. The microcomputer develops a reset pulse for the AIU IC at pin 12 of U3100. The AIU reset pulse occurs shortly after the system control microcomputer is reset. If either reset operation is missing, a dead set symptom could result.

As soon as the AC power is applied, the +12V STBY voltage begins to increase. The +5V STBY regulator Q4160 turns on immediately because the base bias voltage of 5.6V is supplied from a zener diode reference network. Next, the PNP Standby Sense transistor Q3103 turns On because the voltage provided to emitter by the +5V STBY supply is greater than the voltage developed at its base by R3113 and R3118. When Q3103 turns on, a Hi is applied to the base of Q3102 (the Reset transistor) and it turns on. With Q3102 on, a Lo is applied directly to the base of +5V switch transistor Q3101 and to U3100-1 through CR3101.

As the +12V STBY voltage rises to the point where the base voltage of Q3103 exceeds its emitter voltage, Q3103 turns off. Reset transistor Q3102 then turns off and Q3101 turns on due to the voltage supplied through R3114 to its base. When +5V switch Q3101 turns on, power is provided to the AIU and C3125 begins to charge through R3122. The voltage at U3100-1 rises to +5 volts within 500msec (1/2 sec) and the System Control μC is reset. At this time the μC outputs the reset pulse for the AIU from pin 12. R3115 (between Q3102-C & Q3103-B) is provided in the circuit to guarantee a minimum Lo interval during a short duration AC dropout.

The +5V Switched supply is turned off during AC power dropouts or whenever the +12V STBY supply voltage falls below the reset threshold (about +9 volts). The +5V SW supply is turned off because the Reset transistor (Q3102) controls the +5V switch transistor (Q3101). Turning off Q3101 removes the load of the +5V SW supply from the +5V STBY supply. Removing the load of the +5V SW supply allows C3129 to provide memory backup power to U3100. Memory backup power is designed to last for a approximately 10 seconds.

System Control Reset Troubleshooting

The reset operation can be checked by monitoring the voltage at pins 1 and 12 of U3100 during application of AC power.

- The voltage at pin 1 should increase from 0V to 5V within 500msec after the set is plugged in. If pin 1 is not pulled high, check U3100-40 for approximately 5 volts. If the voltage at Pin 40 is missing, suspect the

+12-volt standby supply or the +5-volt standby regulator. If the voltage is present, suspect an open R3122, a leaky C3125, transistors Q3101, Q3102, or Q3103, or a defective U3100.

- The voltage at pin 12 should go from low to high after pin 1 reaches a +5-volt level. If pin 12 of U3100 does not go high after pin 1 reaches +5 volts, U3100 is not operating properly. If the 4MHz clock signal is present at U3100-38, suspect that U3100 is defective. If U3100 provides a high at pin 12, ensure that the voltage at U3300-32 also goes high. If the voltage at U3300-32 does not go high and R3307 is good, suspect that U3300 is defective.

System Control Communications

To control the major functions within the chassis, the System Control μC must communicate with the AIU (U3300). Communications between the AIU and the system control microcomputer are provided using a 3-wire, serial bus. The 3-wire serial bus consists of the Data, Clock and Enable lines.

The serial bus communications are synchronized by the 125kHz clock signal generated at pin 33 of the system control microcomputer. The system control μC generates the 125kHz clock signal by internally dividing down the 4MHz reference clock signal. The 125kHz clock signal is output at pin 12 only during data transmissions. When the clock is inactive, U3100-34 is pulled Hi.

An enable line is used to distinguish between address and data information on the data bus. When the enable line is logic Lo, the address information is transmitted. When the enable line is logic Hi, data information are transmitted.

The digital information on the data line, at pin 34 of the AIU integrated circuit, can be generated by either the system control microcomputer or the AIU. The System Control μC (U3100) controls all communications on the data bus and also controls the state of the enable line. The AIU only transmits data when the System Control μC requests information.

System Control Communications Troubleshooting

It is difficult to determine whether the information on the communication lines is correct using conventional test equipment because of the complex timing used for synchronizing the signals. You can determine if signals are present or missing by monitoring the communications lines with an oscilloscope. Using this technique, system control communication problems can be isolated to the component level.

A failure in communications between system control microcomputer U3100 and AIU U3300 results in a dead set symptom. If the microcomputer and the AIU are operating normally, activity will be present on all three communications lines whenever the set is plugged into AC power. The activity changes when one of the front panel or remote control buttons is pressed.

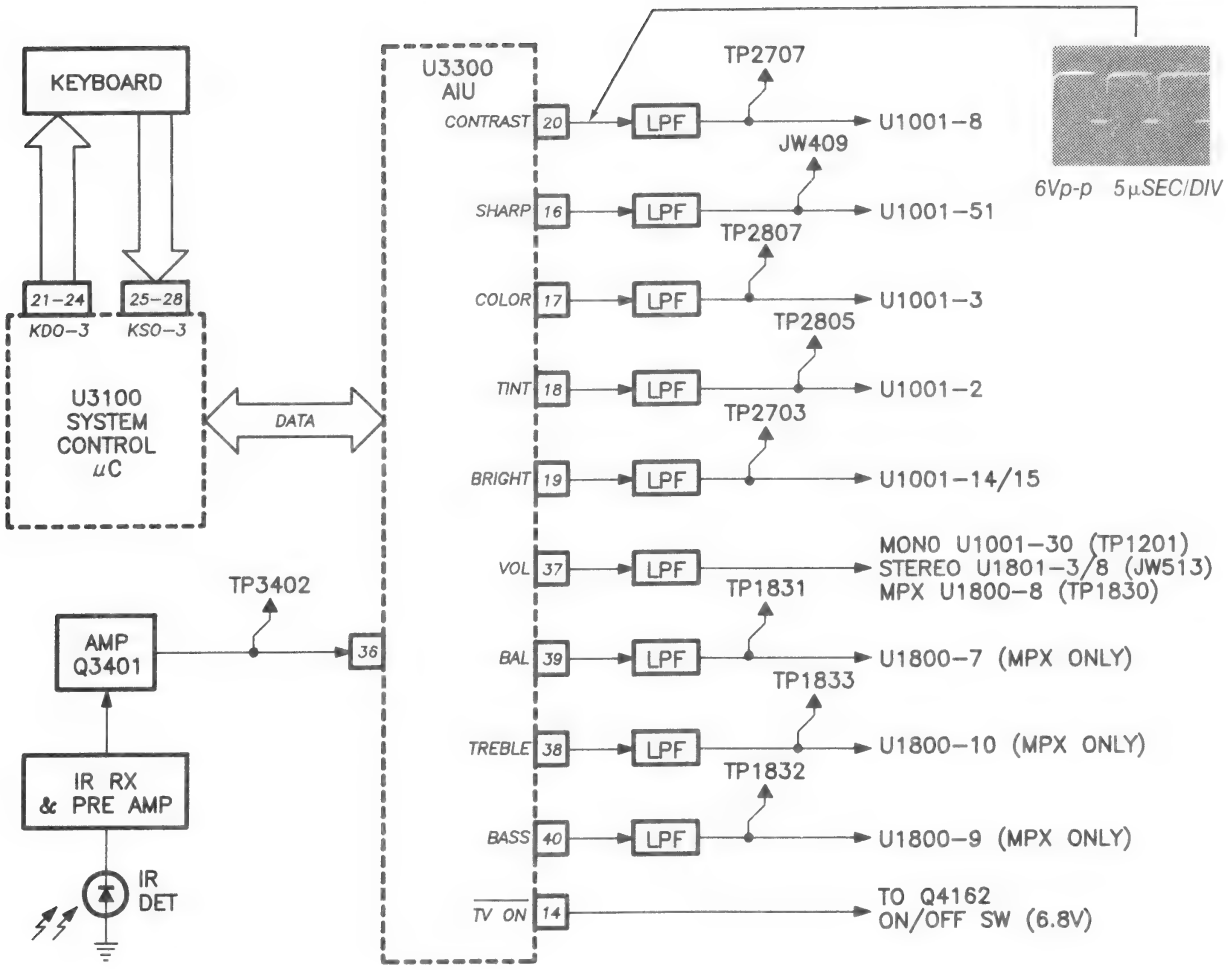
When troubleshooting communications lines, check for activity on the lines (set oscilloscope to 2 msec per division and 2 volts per division). The signals are 5Vp-p with very fast rise and fall times. If activity is present, assume that the data is correct. It is necessary to check both the microcomputer (pins 13, 31, 32, and 33) and the AIU (pins 33, 34, and 35) and confirm activity at both devices.

It is possible to have an open series resistor, or have a malfunction in the AIU that may not be noticeable at the microcomputer because a normal waveform would be observed on the microcomputer side.

- If the waveform is missing, unsolder the pin at the microcomputer and check the signal directly on the pin.
- If the signal is missing, suspect the microcomputer.
- If the signal is present, suspect a malfunction in the AIU.

The Step-By-Step procedures listed below are not associated with a particular symptom but are intended for generalized troubleshooting checks. More detailed Symptom–Check procedures are outlined in the preceding text. These procedures are intended to help the technician verify general circuit operation and not necessarily pinpoint specific malfunctions related to a given symptom. The checks listed below are intended only to familiarize the technician with the major test points and signals in a circuit and to provide him with a starting point in his troubleshooting.

1. Check $\overline{\text{RES}}$ @ U3100-1.
2. Check $\overline{\text{AIU RES}}$ @ U3100-12.
3. Check $\overline{\text{XRP DET}}$ @ U3100-36.
4. Check OSC @ TP3113.
5. Check Clock @ U3100-33.
6. Check for Activity @ TP3110.
7. Check for Activity @ TP3112.



Customer Control Interface

Customer Control Interface

The System Control μC U3100 and the AIU U3300 provide the interface between the operator and the instrument. All customer control functions are generated electronically. These controls consist of the normal Contrast, Brightness, Color, Tint and Sharpness along with Volume and On/Off. Balance, Treble and Bass controls are provided in the high end audio systems.

The two (2) inputs to the system are the Keyboard and IR Receiver. The keyboard information is input at pins 21-24 and 25-28 of the System Control μC U3100. The keyboard scan circuit is discussed in detail in the keyboard section of this manual. The second input to the system is via the Infrared Receiver (IR). The IR signal from the receiver is first amplified by Q3401 and input directly to U3300 at pin 36. The remote command are first processed internally by U3300 and then sent to the System Control μC which decodes the information and outputs the necessary instructions back to the U3300 in order that the AIU can perform the selected function (change channels, turn On or Off, Volume Up or Down, etc.).

The keyboard input data is interpreted directly by the system control μC which then outputs the function instructions to the AIU.

sary instructions back to the U3300 in order that the AIU can perform the selected function (change channels, turn On or Off, Volume Up or Down, etc.).

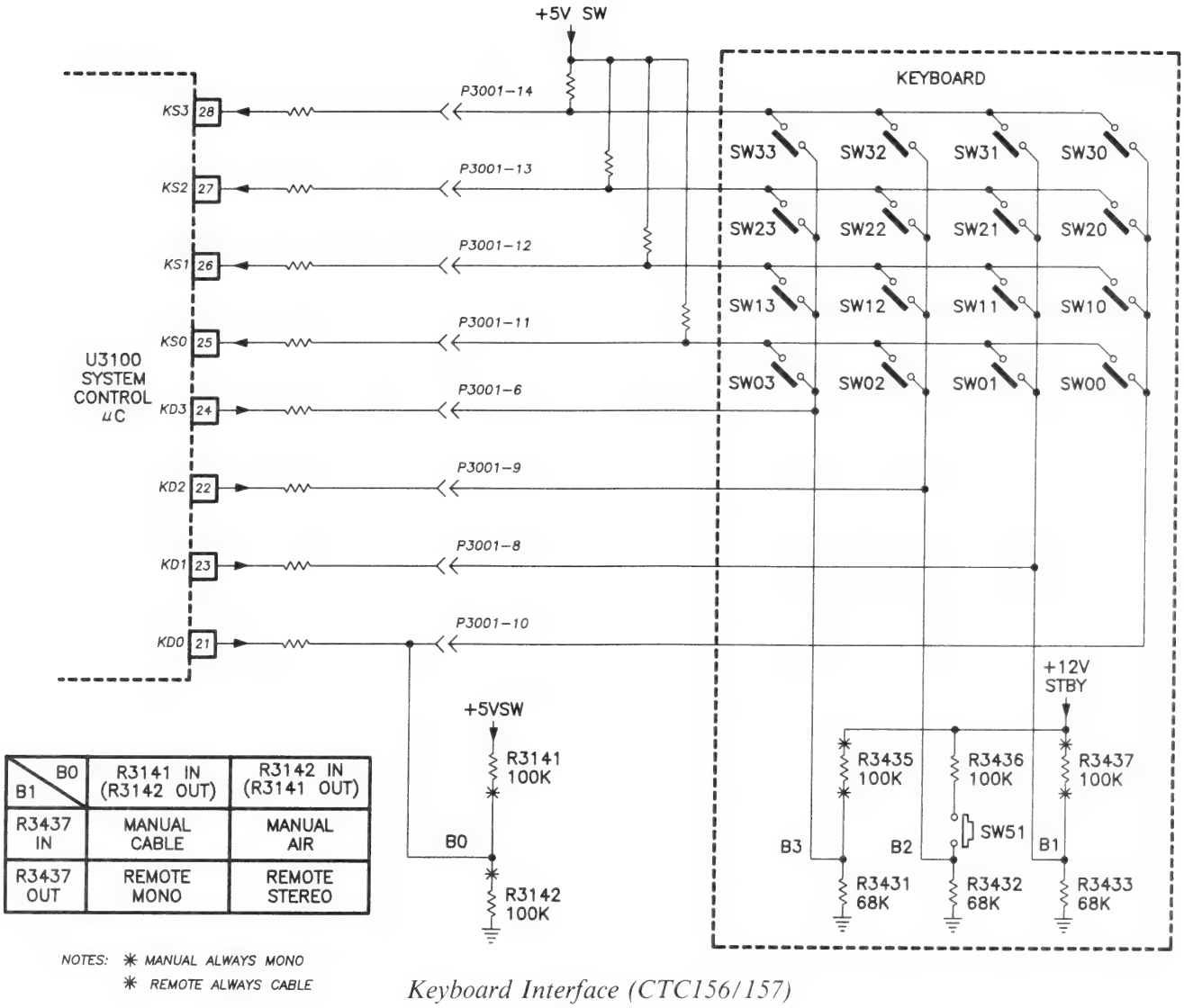
The AIU interprets this control data (customer desired operation) and outputs the appropriate control signals. Except for the $\overline{\text{TV ON}}$ signal at pin 14 of U3300, all customer operation signals are output from U3300 in the form of Bianary Rate Multiflier (BRM) signal. These BRM signals are slightly different from the more common PWM or Pulse Width Modulated signal. Unlike the PWM signal, whose duty-cycle changes, the BRM duty cycle remains constant while the repetition rate is changed to increase or decrease the desired DC control voltage that is output from the Low Pass Filters (LPF). For example; as the Contrast control is moved from its lowest to highest position (On-Screen-Display), the repetition rate of the BRM signal increases thus the DC control voltage at TP2707 goes up. This same principle is true for all customer control outputs from U3300 (except $\overline{\text{TV ON}}$ output @ pin 14). This signal is a Hi to Lo (active Lo) signal that is applied to Q4162 in order to turn the TV on or off.

Troubleshooting

If all keyboard customer controls are inoperative, determine if the remote hand unit (remote instruments) will operate customer controls. If the remote hand unit does not operate controls, check remote hand unit first (is the battery OK ??) and then check for the IR input at pin 36 of U3300. If only one function is inoperative, more than likely the problem is located in the corresponding LPF (on the output of (U3300) or in the signal processing circuit associated with that function. If the remote works, insure that the keyboard matrix is operating properly (see keyboard matrix section). If the keyboard and remote unit check OK, verify that the system control μC is outputting the control data. If the digital communication signal between the μC and the AIU doesn't change when a function button is pressed, suspect U3100. If the digital control data changes, check the BRM outputs of U3300. If the BRM outputs are not present, suspect U3300. However, if the BRM outputs are OK, check the LPF's and their corresponding signal processing circuits. Again, if all customer controls are inoperative, the problem is likely associated with the System Control μC, AIU, the Keyboard or the remote receiver. However, if only one or two controls are involved, the failure in probably located in the LPF's or their corresponding signal processing circuit areas.

The Step-By-Step procedures listed below are not associated with a particular symptom but are intended for generalized troubleshooting checks. More detailed Symptom–Check procedures are outlined in the preceding text. These procedures are intended to help the technician verify general circuit operation and not necessarily pinpoint specific malfunctions related to a given symptom. The checks listed below are intended only to familiarize the technician with the major test points and signals in a circuit and to provide him with a starting point in his troubleshooting.

1. All Functions Inoperative?
2. Verify Remote Operation.
   - Check battery!!
3. Check IR Input (U3300-36).
4. Check Keyboard.
5. Check BRM Outputs.



Keyboard Interface (CTC156/157)

Keyboard Interface

The front panel buttons provide the direct interface between the user and the System Control μC U3100. The remote models do not have the digit keys 0-9 on the front panel however the the front panel keyboard does access the Color, Tint, Brightness, Contrast and Volume, etc. The digit key (0-9) operation, may be accessed in remote models via the hand unit. Manual models are provided with digit keys (0-9) on the front panel keyboard and all other control features such as Tint, Color, Brightness and Contrast, Volume, etc. and are accessed directly by using the front panel keyboard. In CTC156/157/158/159 chassis, all operational status information is provided by an on-screen display.

The keyboard drive lines (KD0-KD3) are used to detect a "Keyboard Code" that identifies the keyboard and chassis configuration to the system control microcomputer U3100. The keyboard code is read by the micro during the initialization process that occurs after AC power is applied.

The keyboard code consists of four bits (B0-B3). Each bit may be either high or low. If the pull-up resistor is installed, then the bit is high. If the pull-up resistor is not installed, then the bit is Lo.

Bit 1 (B1) is the Manual/Remote bit. If R3437 is installed, approximately 5 volts is detected at KD1 from the +12V STBY supply by the voltage divider formed by R3437 and R3433. The high at KD1 identifies the set as a Remote model to the micro. If R3437 is not installed, KD1 is pulled low by R3433 and the set is identified as a Manual model.

Bit 2 (B2) and Bit 3 (B3) identify the functions of the individual keys in the keyboard matrix. Changing the state of these bits determines the individual function of the keys. Switch 51 (B2) is used in order to allow the same keyboard to be used in a horizontal or vertical installation. Switch 51 is not found on all keyboards. Keyboard CBA's that have switch 51 installed, a small protrusion on the inside of the front mask activates the switch when the keyboard is installed in the cabinet. The keyboard layout (key function) is altered, depending on whether the switch is closed or open. Therefore, when removing the keyboard from the cabinet it is necessary to determine if Switch 51 is installed and also if it is closed or open when the keyboard is installed. If the proper position of switch 51 is overlooked, some confusion could occur with the operation of the keyboard while it is removed from the cabinet.

Bit 0 (B0) has a different function depending on the state of Bit 1. If Bit 1 is Hi (R3437 installed–Manual chassis), then Bit 0 identifies the tuner as Air or Cable. If Bit 0 is Lo (R3142 installed/R3441 Removed) in a Manual model, then the chassis is equipped with an Air-Only tuner. If Bit 0 is Hi (R3141 install/R3442 removed) in a manual chassis, then the chassis is equipped with a Cable tuner. This causes the microcomputer to output the proper control signals to the AIU during tuning so that the correct bandswitching voltages and tuning voltages are provided. If Bit 1 is Lo (Remote chassis), then Bit 0 is used to identify the chassis as a Mono or Stereo chassis. All remote chassis have Cable tuners and all Manual chassis have a Mono audio system.

After the initialization routine is complete and the keyboard code is read, the System Control μC U3100 is ready to accept user inputs. Initially, all keyboard drive lines (KD0-KD3) are pulled low by the micro and all keyboard sense lines (KS0-KS3) are pulled high through resistors by the +5V SW supply. When a front panel key is pressed, the keyboard drive line pulls the corresponding keyboard sense line low through the closed switch. The system control μC then begins scanning to determine which key has been pressed. The microcomputer drives each keyboard drive line high and then low, one line at a time, to determine which key is pressed. For example; if SW33 is pressed, KS3 goes low and the micro begins scanning the keyboard matrix. When KD3 is driven high then low, the micro receives this pulse at KS3 through SW33 and determines that SW33 is pressed. Once the micro determines which key is pressed, it consults its stored program and activates or performs the appropriate action.

Keyboard Troubleshooting

A simple continuity check of the keyboard is the easiest way to isolate a keyboard problem. To confirm operation of the scanning system, press and hold a front panel keyboard button and use an oscilloscope to monitor the appropriate drive and sense lines for signal activity. Repeat the process for each key. If the front panel keys do not control the correct functions or the chassis fails to tune cable channels (cable ready models only), suspect a malfunction of the keyboard circuit. Measure the resistance from each keyboard drive line to ground and the +12V STBY supply with no AC power applied to the chassis. Confirm that all connections are correct by checking the keyboard code chart on the Service Data schematic.

The Step-By-Step procedures listed below are not associated with a particular symptom but are intended for generalized troubleshooting checks. More detailed Symptom–Check procedures are outlined in the preceding text. These procedures are intended to help the technician verify general circuit operation and not necessarily pinpoint specific malfunctions related to a given symptom. The checks listed below are intended only to familiarize the technician with the major test points and signals in a circuit and to provide him with a starting point in his troubleshooting.

1. All Functions Inoperative?
2. Check Continuity of Switches.
3. Check Scan Pulses.

Tuning Control

The tuning system used in CTC156/157/158/159 chassis is very similar to that used in CTC145/146 and CTC148/149 chassis. CTC156/147/158/159 chassis initiate the autoprogramming sequence the first time the chassis is turned on after it is plugged into AC power (or any time the micro is reset) because no EEPROM (permanent memory) is provided. This requires that the antenna or cable be connected before the power is turned on for the first time. If the antenna is not connected during first time power on, the active channels are not programmed into the channel scan list. Autoprogramming may be manually initiated by using the setup menu.

The tuning system is a Frequency Synthesis (FS) type with a crystal-controlled phase-locked loop. The block diagram illustrates the major components of the tuning system. Control of the tuner is provided by the AIU (U3300). The operation or control of the AIU is provided by data from the micro U3100.

The tuning system consists of two loops:

1. The System Control μC, AIU, Band Switch, and the Tuner – responsible for setting the tuner to the desired frequency.
2. The Tuner, the System Control μC, the AIU, and the IF/Video Detector – used to keep the tuner on frequency, adjust for offset channel frequencies, detect stations during autoprogramming, and adjust for changing signal strength by changing the gain of the tuner.

A malfunction in either loop can cause a no picture symptom. Other malfunctions associated with the tuning control circuit include slow tuning, drifting, and autoprogramming problems.

The tuner uses a number of varactor diodes in the local oscillator circuits. These diodes act like variable capacitors. The capacitance changes in relation to the voltage applied to the diode and this changes the frequency of the oscillator circuit. The tuning control circuit controls the tuning voltage that is applied to the diodes. The tuning control circuit also determines which diodes are used for each band of frequencies to be tuned. Band selection is controlled by bandswitching signals from the AIU.

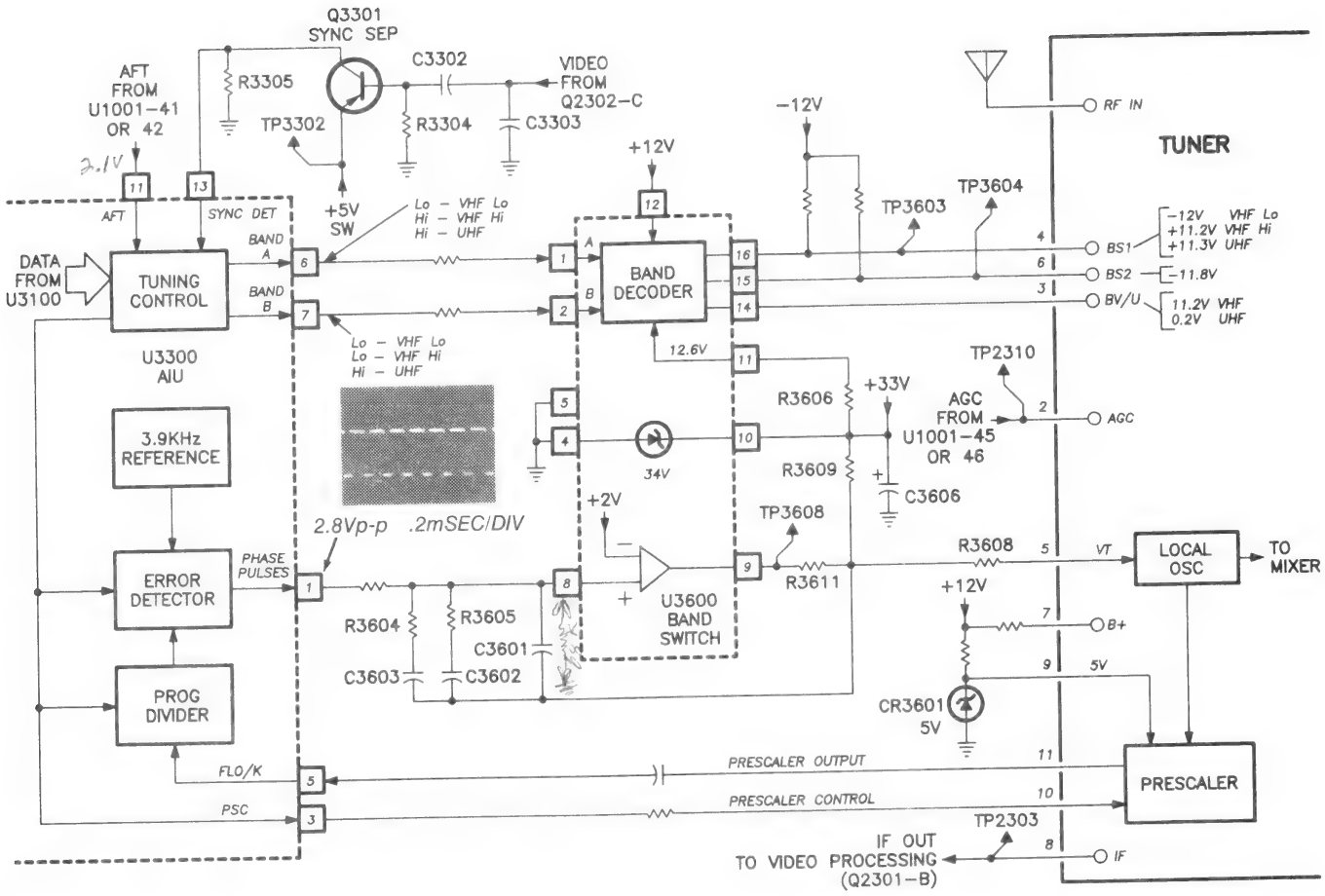
First Loop Operation

The first tuning control loop generates the bandswitching voltages as directed by the data from the system control μC. The first tuning control loop also generates the tuning control voltage by using the following signals:

1. A tuning control data signal that is supplied by the system control μC.
2. A frequency reference signal (3.9KHz) that is generated within the AIU.
3. A feedback control signal (PSC) that is generated within the AIU and output at pin 3 The PSC changes depending on the channel being tuned.
4. A frequency control signal that consists of the phase pulses from the AIU and is output from pin 1.
5. A local oscillator frequency feedback signal (FLO/K) that is the output of the prescaler (pin 11 of Tuner).

Both the bandswitching circuits and the tuning voltage control circuits must operate correctly for the proper tuning voltage to be produced. If the bandswitching circuits malfunction, the wrong local oscillator circuits are enabled and the local oscillator frequency is incorrect. The tuning control circuit then changes the tuning control voltage to attempt to make the FLO/K frequency correct. In order for the tuning control circuit to synthesize the correct tuning control voltage, all signals used by the tuning control circuit must be correct.

When the channel is changed, the system control μC supplies the tuning control data signal to the AIU. This data signal is a binary number that represents the desired frequency of the local oscillator. The AIU interprets the data and generates the appropriate bandswitching signals and feedback control signals. The feedback control signals include signals used within the AIU and the PSC signal provided to the prescaler in the tuner.



Tuning Control

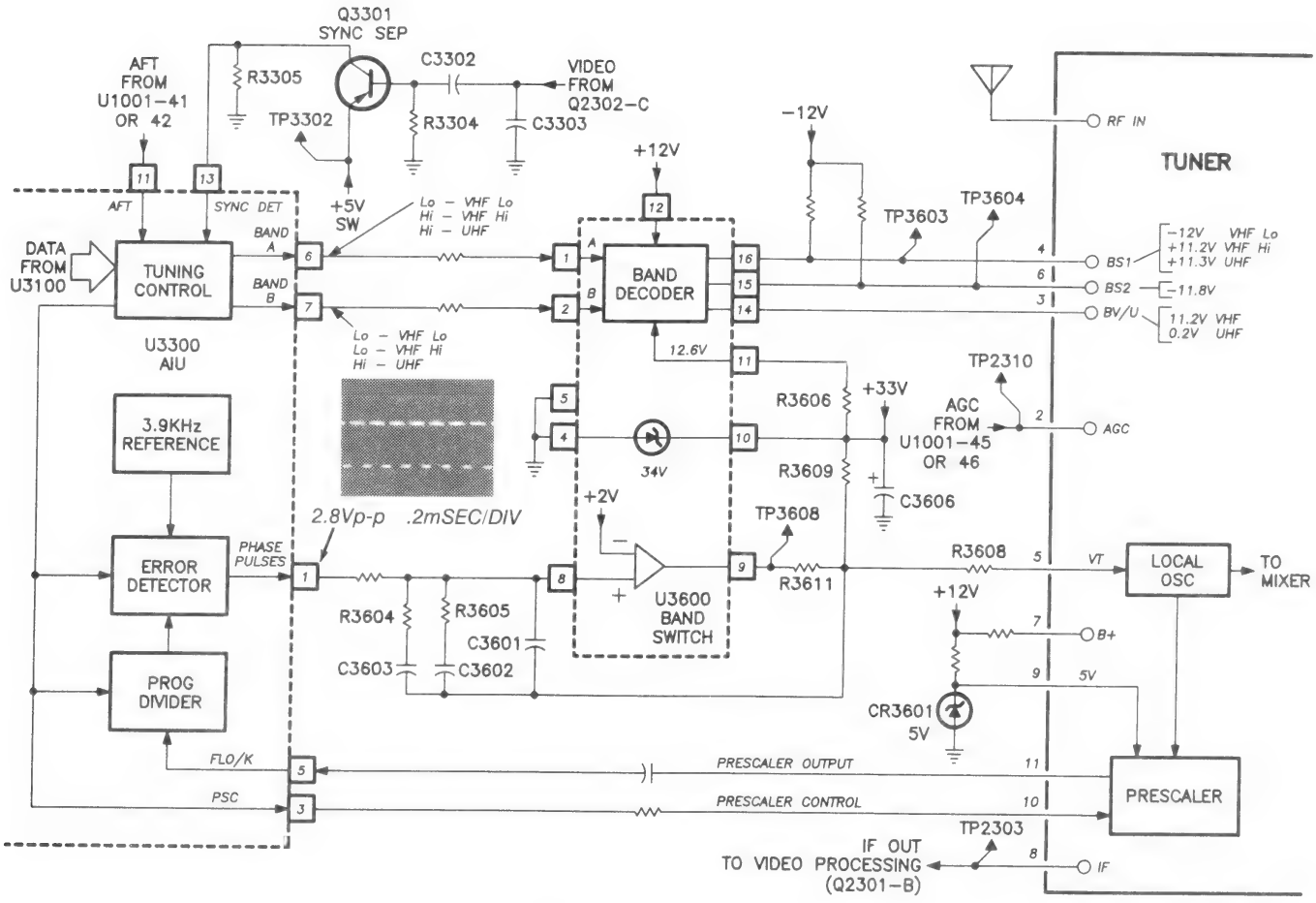
The prescaler is a programmable divider that is controlled by the PSC (Pulse Swallow Control) signal from pin 3 of U3300. The prescaler generates a divided down local oscillator signal (FLO/K). Division of local oscillator signal produces a low-frequency sample and permits the use of a low-frequency reference, or comparison signal in U3300. A low-frequency reference signal is easier to generate and control than a high-frequency signal.

For VHF channels on nominal FCC frequencies, the division ratio of the prescaler is normally 1/128 and no PSC pulses are output. For UHF and cable channels, between 1 and 15 PSC pulses are generated in a 256μSec period. Each time the PSC signal goes logic Hi, the division ratio of the prescaler is set to 1/136. Generation of PSC pulses is controlled by the tuning control circuit within U3300. PSC pulses may be momentarily present during channel changes regardless of the channel selected. If PSC pulses are generated when tuning VHF channels on nominal FCC frequencies, the AFT circuit is probably out of alignment. Refer to the service data for the alignment procedure.

Bandswitching is accomplished by the AIU and the Band Decoder IC U3600. Bandswitching control signals A and B are output from the AIU at pins 6 and 7 and are applied to the Band Decoder in U3600. Bandswitching control signals A and B are either 0 volts (Lo) or +5 volts (Hi). Refer to the diagram for the correct output of the bandswitching signals from the AIU. The three outputs of the Band Decoder (U3600-14/15/16) are applied directly to switching circuits in the tuner.

The Frequency and Bandswitch voltage levels on the diagram gives the specific voltage states for each bandswitching line during tuning of the various bands. Bandswitching lines BS1 and BS2 can be pulled up to +12 volts and pulled down to −12 volts, but bandswitching line BV/U is either pulled up to +12 volts or set at 0 volts.

The prescaler in the tuner divides the output of the local oscillator. The resulting output signal (FLO/K) is routed to the AIU where it is used as the feedback signal. The FLO/K signal is divided again by the programmable divider in the AIU. The output of the programmable divider is applied to the error detector where it is compared to the 3.9kHz reference frequency. The difference between the two signals is used to control the generation of the phase pulses.



Tuning Control

The phase pulses are integrated by the RC network between pins 8 and 9 of U3600. The resulting DC voltage is amplified by the VT amplifier in U3600 and the output at pin 9 becomes the tuning voltage (VT).

If the tuning voltage is low, the frequency of the local oscillator is below the reference frequency. The VT amplifier is an inverting amplifier, so negative phase pulses are generated to cause an increase in the tuning voltage.

If the frequency of the local oscillator is too high, the error detector develops positive phase pulses to lower the tuning voltage and the frequency of the local oscillator. When the frequency is correct, no phase pulses are developed. The phase pulses are present only while changing channels (searching for a station). The pulses are integrated and the resulting DC voltage is applied to the VT amplifier. This DC voltage is approximately +1.9 volts and varies less than 25 millivolts from one end of a band to the other. Because the VT amplifier is configured as an inverting amplifier, the DC output voltage decreases as the input voltage increases.

For example, the voltage at pin 8 of U3600 is +1.944 volts when channel 2 is properly tuned and +1.929 volts when channel 6 is tuned. The tuning voltage at pin 9 of U3600 is +2.64 volts on channel 2 and +11.72 volts on channel 6. These voltages were taken from a typical receiver and should not be considered as the exact values. They are intended to serve as examples of the range of voltages present at the points indicated. The voltages will vary slightly for different tuners and control circuits.

Tuning Control Troubleshooting

First Loop

The first tuner control loop will set the tuner frequency to the nominal or default frequency for the specified channel even if the second tuner control loop fails to function. The tuning system will default within two seconds when no RF input is provided or the second tuning control loop is inoperative.

To confirm the operation of the first tuning control loop, check the voltage at pin 5 of the tuner.

- The voltage should remain constant (after two seconds have elapsed) as long as the channel is not changed.
- The voltage should be between +0.5 and +30 volts.
- The voltage should increase when the channel is increased in the same band (for example the voltage for channel 2 is about +2.6 volts, the voltage for channel 3 is about +4.3 volts, and the voltage for channel 6 is about +11.7 volts).

If the voltage of consecutive channels follows the above pattern in all bands, the tuning system is functioning properly even though the picture may be blanked and the sound muted.

If the tuning voltage does not remain constant on each channel, is not appropriate for the channel selected, or stays constant at either 0 or +35 volts, it is likely that a tuning problem exists. Using the Frequency and Bandswitch State Chart in Appendix A, verify that the proper bandswitching voltages are getting to the tuner for the band that is selected.

If the bandswitching voltages at the tuner are incorrect:

- Verify that the inputs to the band decoder from the AIU are correct.
- If the inputs to the band decoder are missing or incorrect, suspect a malfunction in the AIU.
- If the voltages to the band decoder are correct but the output to the tuner is missing or incorrect, suspect a malfunction in either the band switch IC, the pull up/pull down supplies, or the tuner itself.

To confirm that the tuner is operating normally, unsolder the bandswitching pins and use an external DC supply to provide the proper voltage to the bandswitching inputs. The tuner should function normally.

If the bandswitching voltages are correct, use a DC power supply to provide the tuning voltage to pin 5 of the tuner. Power supply voltage must not be allowed to rise above +34 volts.

- Monitor the FLO/K signal at pin 5 of the AIU and verify that the frequency increases as the tuning voltage is increased.
- If the frequency of the FLO/K signal does not change, the tuner is defective.
- If the signal changes normally when the voltage is increased, check for the presence of activity at pin 1 of the AIU when the channel is changed.
- If pulses are present suspect a malfunction in U3600 or the RC network connected between pins 8 and 9 of U3600.
- If the pulses are missing, the problem is in the AIU.
- Select channel 2 in the VHF low-band and adjust the voltage applied to tuner pin 5 to each of the voltages shown at pin 5. Measure the FLO/K frequency produced at each voltage and compare it to the frequency listed for that channel in Appendix A.
- If the frequency produced differs greatly from the frequency listed, suspect the tuner.
- Select the lowest channel in each of the remaining bands that the tuner is designed to tune (air-only tuners will not tune band 3). Use the power supply to sweep the tuning voltage from the lowest voltage obtainable to +30 volts. Check that the FLO/K frequency will change throughout the full range of frequencies listed for that band. If the frequencies produced do not cover the full range, suspect the tuner.

Second Loop Operation
The second tuning control loop provides the following functions:

- Automatic fine tuning to keep the tuning system on frequency.
- Tuning compensation for channels on offset frequencies.
- Station detection during autoprogramming.
- Tuner RF automatic gain control (AGC).

To perform these functions, the second tuning control loop requires the following inputs:

- Data from the micro to direct the operation of the AIU.
- Sync from the video signal to detect stations during autoprogramming and activate the AFT circuits in the AIU.
- AFT from the IF/video detector circuits of U1001.
- AGC from the IF/video detector circuits of U1001.

The data, AFT, and AGC signals are provided directly from the circuits indicated. The sync signal is separated from the video signal by the sync separator Q3301. The output of Q3301 is 5-volt, positive-going, composite sync. The input to Q3301 is video with negative sync. The video level is 3-to-3.5 volts with about 1 volt of that amount being sync.

AFT voltage is generated within the IF/video detector section of U1001. The AFT voltage fluctuates between 0 and +5 volts at pin 11 of the AIU as the IF output signal varies below and above 45.75MHz. As the IF signal swings through the center frequency of 45.75MHz, the AFT voltage crosses through a balance point between about +2 volts and +3 volts. This is called AFT crossover. When the IF video carrier frequency is stable at 45.75 MHz, the AFT voltage "balances" at about +2.5 volts at pin 11 of the AIU.

AGC voltage is also generated within the IF/video detector section of U1001. The AGC voltage is about +4.5 volts when a strong signal is being received and about +8.25 volts when a weak signal or no signal is being received. The AGC circuit in U1001 varies the level of the AGC signal to keep the tuner IF signal output level constant.

The tuning operation varies slightly between air-mode and cable-mode tuning. However, complete second loop operation in either mode requires all of the signals listed previously. In order for these signals to be produced, the tuner must operate correctly and produce IF and the IF/video detector in U1001 as well as its associated components must function.

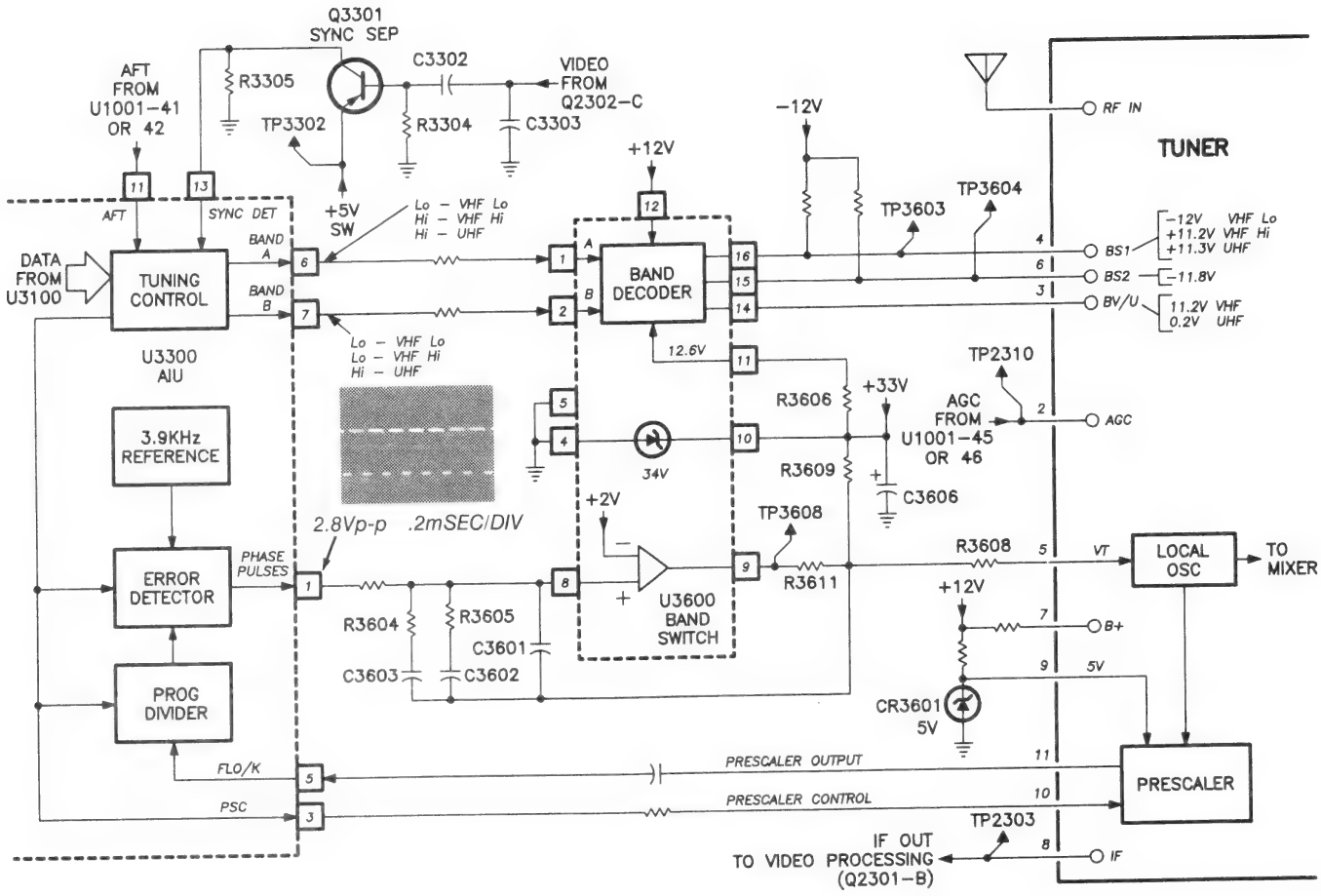
If the first tuning control loop functions, but the second loop does not function, the tuner will still default to the FCC nominal frequency for the channel selected within two seconds. Therefore, channels on FCC nominal frequencies can still be tuned. Second loop problems will usually show up in one or more of the following forms:

- Slow tuning (tuning time greater than 1 Sec)
- Tuning drift
- Failure to autoprogram

During air-mode tuning, the system will look for an AFT crossover while tuning 156 kHz above and below the nominal channel frequency. If an AFT crossover is detected, the nominal channel frequency is synthesized. If an AFT crossover is not detected, the system will search a band several MHz above and below the nominal frequency while looking for valid sync. If sync is detected, the system will use the AFT signal to fine tune the channel. If sync is not detected, the system defaults to the nominal frequency.

During cable mode tuning, the system will look for an AFT crossover while tuning 156 kHz above and below the nominal channel frequency. If an AFT crossover is detected, sync is checked. If valid sync is detected, the nominal channel frequency is synthesized. If an AFT crossover and sync are not detected, the system will check for normal cable channel offset frequencies.

If the channel has not been located, the system will search a band several MHz above and below the nominal frequency while looking for valid sync and AFT crossover. If sync is detected, AFT is used to fine tune the channel. If no sync was detected, but an AFT crossover was detected the frequency where the AFT crossover was detected is synthesized. This allows the system to tune offset music channels and offset scrambled channels that do not have valid sync. If no sync or AFT crossover is detected, the system will default to the nominal channel frequency.



Tuning Control

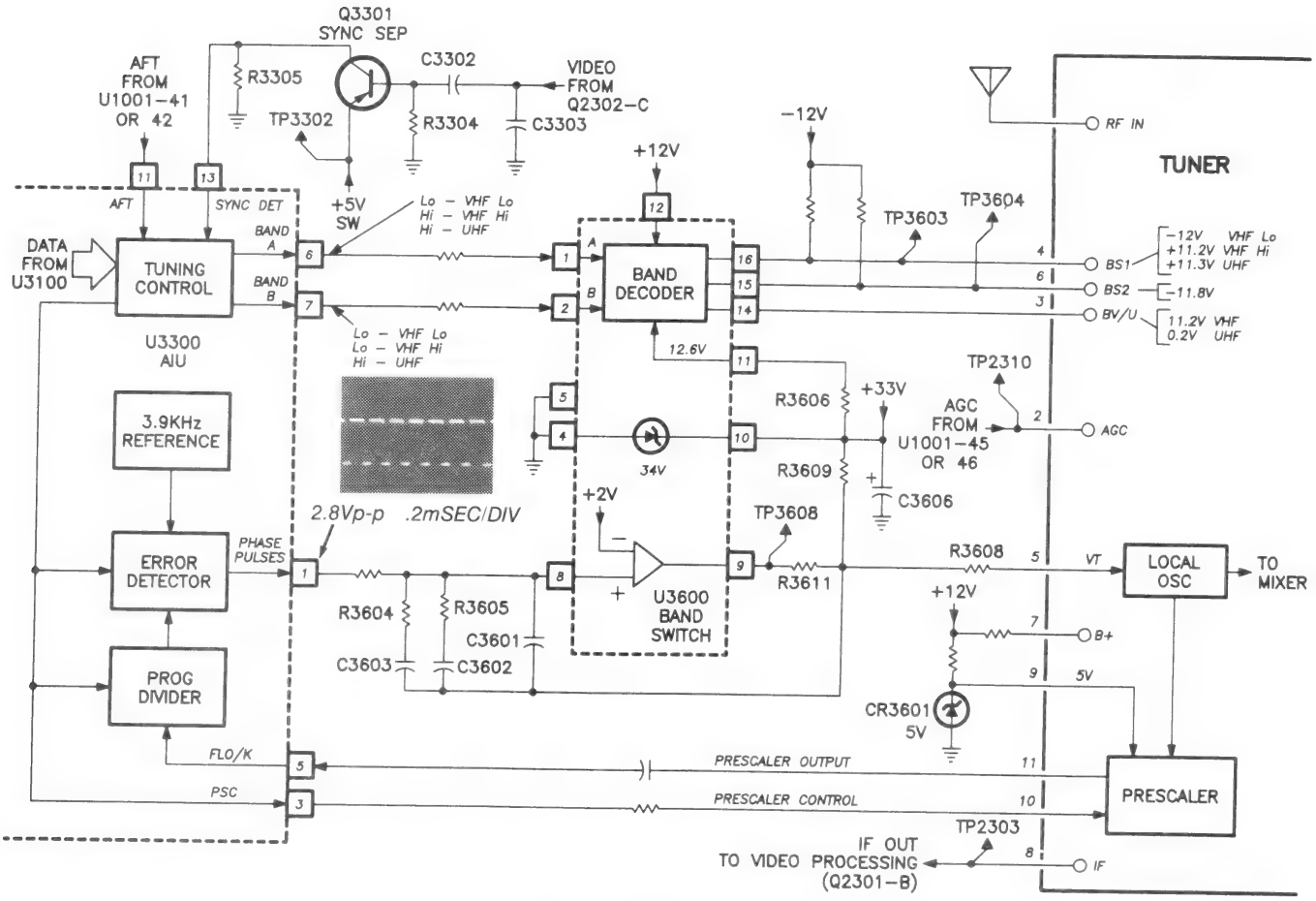
Autoprogramming

During autoprogramming the set automatically determines whether the TV is connected to a cable system or to "off-air" signals. This eliminates the need for a cable/air switch. The feature also adds to the scan list any channels that have valid sync present on them at the time the TV is autoprogrammed. Because the system is looking for valid sync, weak off-air signals might not be programmed. If so desired, the weak channels may be manually programmed by selecting the channel memory feature in the setup menu and then adding the channels.

The tuner is able to tune channels even if the autoprogramming feature is inoperative. Before troubleshooting a autoprogramming malfunction, check to see if the tuner is operating correctly by manually tuning to an active channel. This can be done by accessing an active channel with the remote hand unit or the digit keys on the front panel for manual models. If an active channel cannot be tuned, do not waste time troubleshooting the autoprogramming circuit. The tuner must function properly before the autoprogramming feature can operate.

To confirm proper operation of the autoprogramming system, monitor pin 13 of U3300 with an oscilloscope during autoprogramming. A 5Vp-p composite sync signal should be present when an active channel is detected.

- If the sync signal is present, and no channels are stored in the scan list, suspect a defective micro U3100 or a defective sync detector in the AIU U3300.
- If the sync signal is missing, suspect Q3301 and associated components or the video signal from the signal processing circuits.



Tuning Control

Slow Tuning

Air channels and cable channels, at nominal FCC frequencies, should tune within about 400msec. Offset cable channels should tune within 750msec. Music channels and scrambled channels should tune within 1.6seconds. Slow tuning can be caused by either loss of the sync signal to the AIU or incorrect AFT voltage input to the AIU.

When properly tuned, the AFT voltage is balanced at about +2.5 volts at pin 11 of the AIU and composite sync is present at pin 13 of the AIU. The sync signal consists of 5-volt, positive-going pulses. If the sync pulses are missing suspect Q3301 and associated components or the video signal from the signal processing circuits.

If the AFT voltage is not about +2.5 volts, suspect that the AFT circuit is out of alignment or defective. PSC pulses will likely be found at tuner pin 10, even when tuning FCC nominal channels. Perform the alignment procedure as directed in the appropriate service data or repair the AFT circuit as necessary. If the problem still exists after the repair and/or alignment, suspect the AIU.

Drifting

If the channel is momentarily tuned and then appears to drift off frequency, the AFT tank may be out of alignment. Refer to the service data for the alignment procedure.

The Step-By-Step procedures listed below are not associated with a particular symptom but are intended for generalized troubleshooting checks. More detailed Symptom–Check procedures are outlined in the preceding text. These procedures are intended to help the technician verify general circuit operation and not necessarily pinpoint specific malfunctions related to a given symptom. The checks listed below are intended only to familiarize the technician with the major test points and signals in a circuit and to provide him with a starting point in his troubleshooting.

1. Check VT (Tuner-5)
2. Check AFT & Sync (U1001-11/13).
3. Check AGC @ Tuner-2 (TP2310).
4. Check Band Switching @ U1001-6/7.
5. Check Band Switching @ Tuner-3/4/6.
6. Check for Change in Freq. of FLO/K & PSC During Channel Change.
7. Check Phase Pulse Out (U1001-1) (connect 68K ohm from U3600-8 to ground).

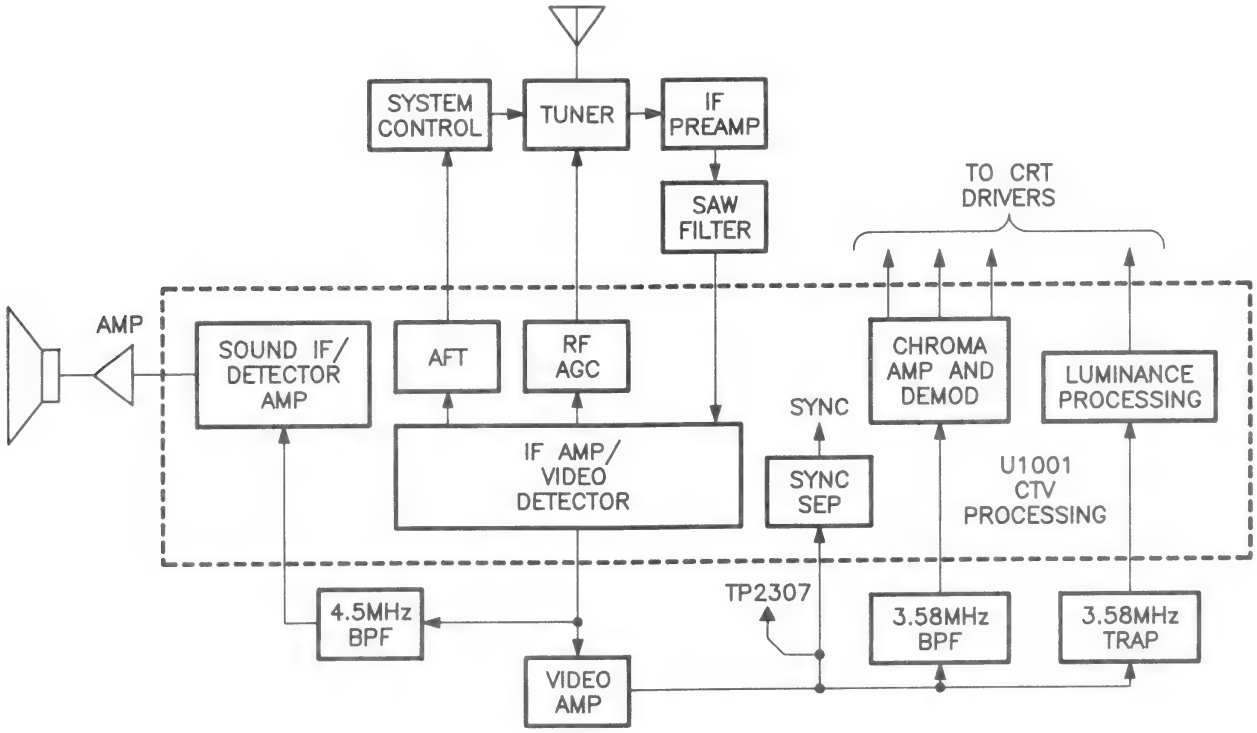
Signal Processing Overview

The majority of both audio and video signal processing functions are performed inside the CTV (Color Television) processor IC U1001. There are two (2) CTV Color Television processors in the CTC 156 thru 159 family of chassis. If the chassis is a CTC156/157 the CTV processor part number 193082 is used. If the chassis is a CTC158/159, part number 180851 is used. Care should be taken when replacing the CTV processor IC since these IC's are not interchangable. Also, it should be mentioned that the functional pinout (signal output pin numbering) is slightly different. However, they are virtually the same from an operational standpoint. Where these differences are of a major concern they will be explained in greater detail. An example of this is in the area of OSD operation. In the CTC158/159 chassis the OSD display is generated and mixed with the video internally within the CTV processor. The CTC156/157 OSD information is mixed with the video at the CRT drivers.

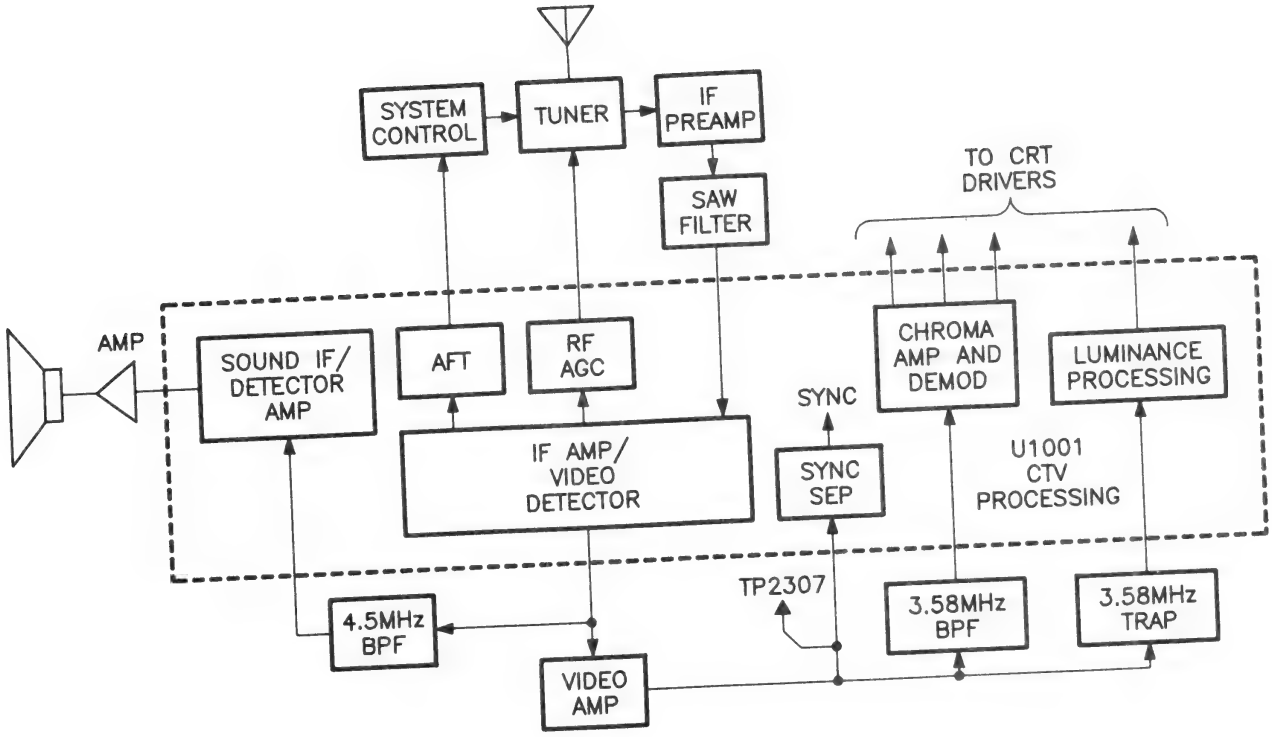
The CTV processor is a 64-pin IC and contains the circuit areas listed below:

- IF Processing/Video Detector
- Sound IF/Sound Detector/Sound Preamplifier
- Luminance Signal Processing
- Chrominance Signal Processing
- Sync Separator
- Deflection Signal Processing (not shown)

The IF output from the tuner is sent to IF preamplifier Q2301 and is then applied to a SAW filter. After leaving the SAW the IF signal is applied directly to U1001. Inside U1001, the signal is first amplified and then sent to a video detector circuit. The AFT and AGC voltages are developed internally by U1001. The AFT voltage is routed back to the IC U3300 (AIU) in the system control circuit. The voltage is used by the AIU during tuning to determine if the tuner frequency is correct for a given channel selection. The RF AGC voltage is applied back to the tuner to control tuner amplifier gain so that U1001 receives the optimum level of IF signal.



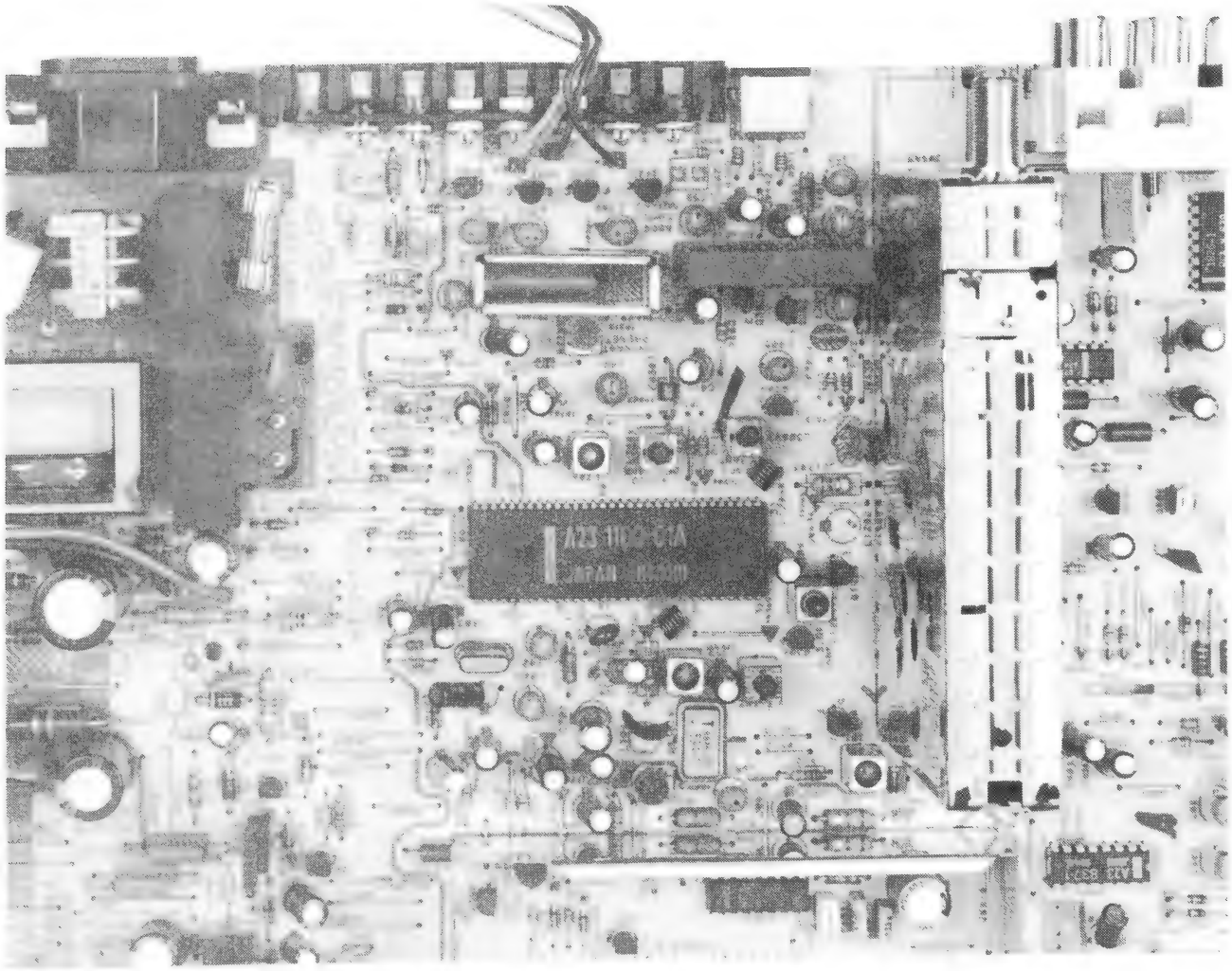
Simplified Signal Processing Block Diagram

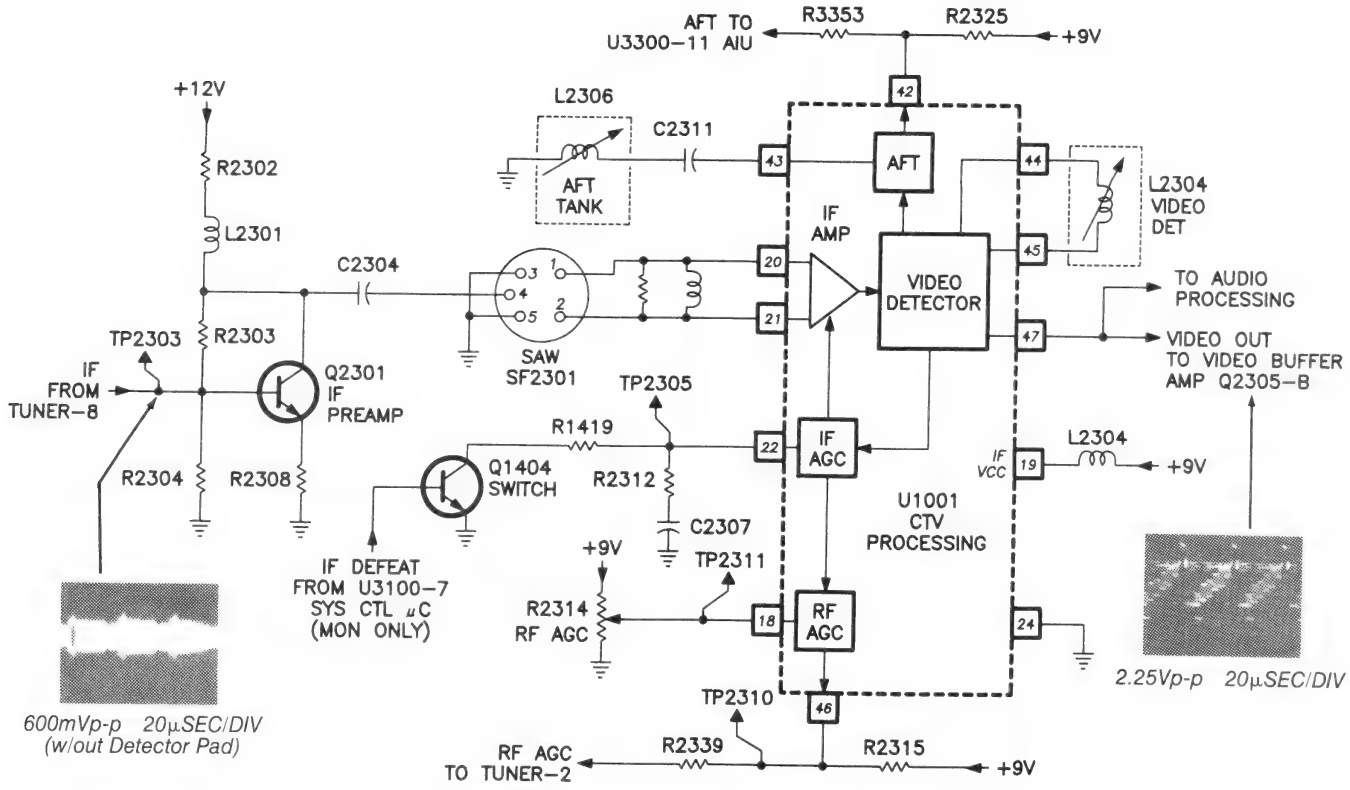


Simplified Signal Processing Block Diagram

The output of the video detector contains the video, chrominance, and the sound carrier information. The audio information is passed through a 4.5MHz bandpass filter and into the Sound IF section of U1001 for further processing. The audio is then detected and amplified in the volume control preamplifier. In the case of Mono instruments the audio signal is then applied to a discrete audio power amplifier circuit and on to the speaker. In the case of Stereo models the audio signal is applied to a Stereo Demodulator and various audio switching circuits and then on to the audio output amplifiers. The details of the different audio systems are discussed in detail in their respective sections.

The output of the video detector is also passed through video amplifier Q2302. The video amplifier circuit contains a 4.5MHz trap to remove the sound carrier information from the video signal. The video signal is then split three ways. First, the video signal is routed to the sync separator in the deflection section of U1001. The video signal is also passed through a 3.58MHz band pass filter (BPF) and applied to the chroma processing circuits in U1001. Third, the video signal is routed through a 3.58MHz trap filter and applied to the luminance processing portion of U1001. The outputs of the chroma processing section are the three color difference signals (R-Y, G-Y, and B-Y) while the output of the luma processing section is the luma (Y) signal. The luminance signal, demodulated chroma signals are then matrixed by the CRT driver/bias circuits.





Pix IF/Video Detector Circuit (CTC156/157)

Pix IF/Video Detector Circuit Operation

The Pix IF/Video Detector circuit is responsible for detecting the video signal and generating the RF AGC voltage, the IF AGC voltage, and the AFT voltage. The IF output signal from the tuner is applied to the base of Q2301, amplified and capacitively coupled to pin 4 of the SAW filter SF2301. The output of the SAW filter (pins 1 and 2) is applied to the IF amplifier input of U1001 at pins 20 and 21. The IF amplifier in U1001 amplifies the IF signal and passes it to the video detector circuits. The video detector is tuned by L2304 at pins 44 and 45. The detected video exits the IC at pin 47. The output at pin 47 is applied to the Video Buffer transistor Q2305. The signal output at pin 47 of U1001 also contains the audio information and is coupled to audio processing portion of IC U1001.

The video detector stage also passes the video to the IF AGC comparator circuit. The IF Defeat signal from U3100-7 (System Control μC) is input at pin 22 of U1001. This input is only used in the Monitor models and is used to turn off the IF circuits in U1001 when using the video inputs. The IF AGC voltage is used to vary the gain of the IF amplifier and is also used by the RF AGC circuit. The RF AGC circuit compares the level of the IF AGC voltage to the level of the RF AGC in order to develop the RF AGC voltage. The output of the RF AGC exits U1001 at pin 46 and is applied to the Tuner at pin 2. Adjustment of the RF AGC is provided by R2314. This control voltage is input at pin 18 of U1001 and can be checked at TP2311. The RF AGC voltage can be monitored at the RF AGC TP2310.

The video detector also provides the IF signal to the AFT detector circuitry. L2303 is used to adjust the center frequency (crossover) for the AFT detector. The output of the AFT detector from pin 42 is applied to pin 11 of the AIU (U3300).

Service Caution: The CTC156/157/158/159 chassis is a "HOT" grounded chassis. Always use an isolation transformer when performing service. Failure to use an isolation transformer could result in damage to the chassis or test equipment or injury to the technician.

PIX IF/Video Detector Troubleshooting

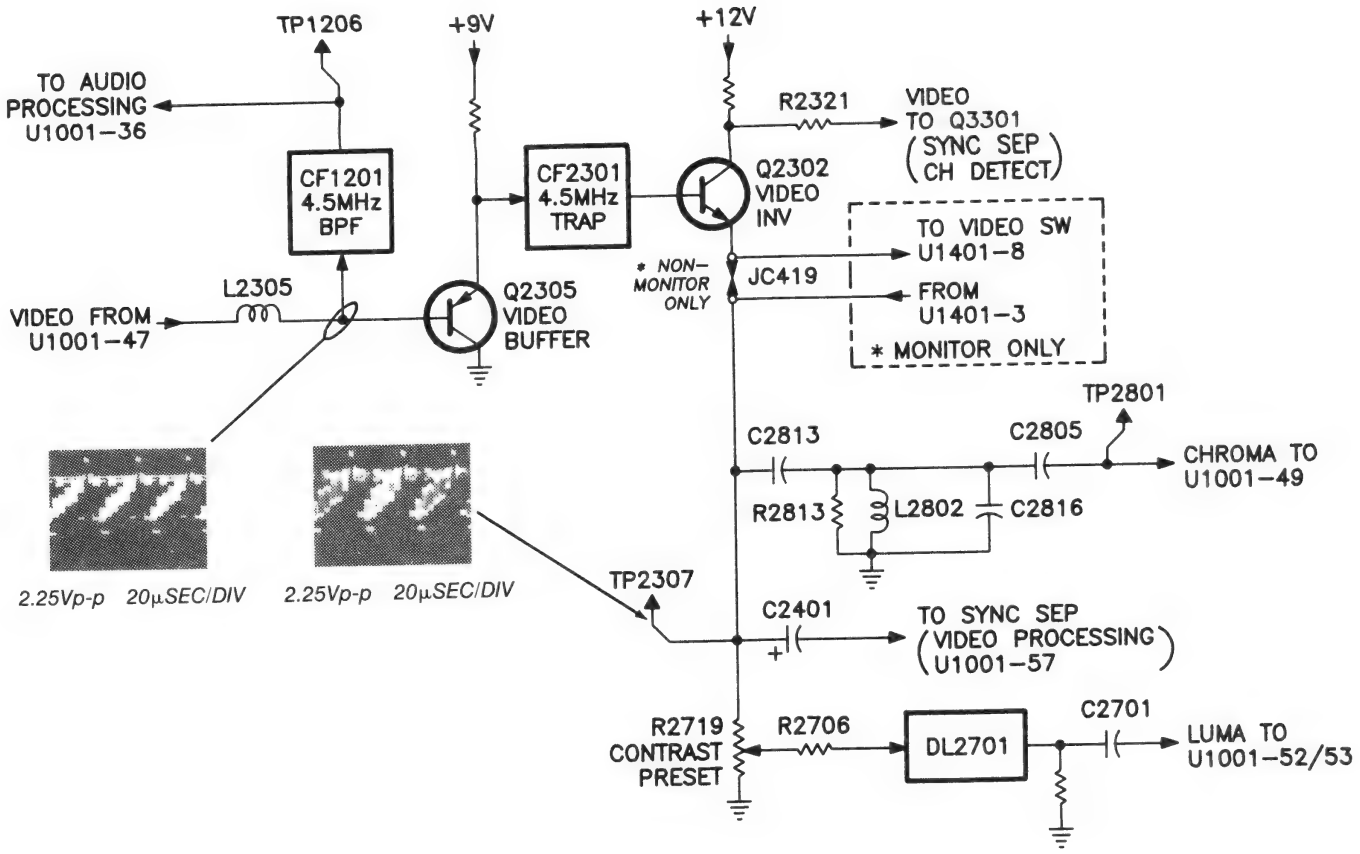
No Sound or Video:
Connect an RF signal to the antenna input and tune to a known-good channel. Using an IF-Detector pad, check for video at TP2302. If not present, troubleshoot Tuner and/or Tuning Control circuits. If video present at TP2303, check Q2301, SAW filter (SF2301) and their components. If input circuitry to U1001 is OK, check for presence of a output video signal at pin 47 of U1001. If video output is present at pin 47, check the Low Level Video Amplifier circuits and the Sync Separator circuits. If video is not present at pin 47 of U1001, check for +9 volts Vcc at pin 19 and ground at pin 24. If supplies check OK, apply a 45.75MHz marker signal to TP2303. Follow the alignment procedure in the service data for video detector alignment and AFT alignment setup.

If the output of pin 47 is incorrect, check the components at pins 44, 45 and 47 or U1001. If the AFT voltage cannot be set to +2.5 volts suspect the components at pins 42 and 43 or U1001. If the RF AGC cannot be set properly, suspect the components at pins 18 and 46 or U1001. If none of the outputs of U1001 are correct, check the components at pin 22 or U1001.

Weak or Snowy Pix
Check the voltage at the AGC test point (TP2310). The voltage should be approximately +8.25 volts with a weak signal and +4.5 volts with a strong signal. If incorrect, check the components at pins 18, 22 and 46 of U1001. Also, check AGC alignment, the tuner, Q2301, SF2301, and U1001. If the AGC voltages are correct, suspect video amplifier circuits connected to pin 47. AGC operation can be checked by connecting a adjustable, stable DC power supply to Tuner pin 2 (RF AGC) and varying the voltage slowly from +4.5 volts to +8.25 volts. If the picture becomes clear at any voltage, check the components at pins 18, 22 and 46, AGC alignment or U1001.

The Step-By-Step procedures listed below are not associated with a particular symptom but are intended for generalized troubleshooting checks. More detailed Symptom–Check procedures are outlined in the preceding text. These procedures are intended to help the technician verify general circuit operation and not necessarily pinpoint specific malfunctions related to a given symptom. The checks listed below are intended only to familiarize the technician with the major test points and signals in a circuit and to provide him with a starting point in his troubleshooting.

1. Check Video IF from Tuner-8
   (Use IF Detector Pad if available)
2. Check Input @ U1001-20/21.
3. Check Video Out (U1001-47).
4. Check RF AGC/AFT Voltages.
5. Check IF Defeat (Mon Only).



Low Level Video (CTC156/157)

Low Level Video (CTC156/157)

The composite (baseband) video signal that is output from the video detector at U1001-47 contains the luminance, chrominance and the sound IF information. The purpose of the low level video processing circuit is to separate these signals and route them to their appropriate processing circuits. The composite video signal from pin 47 of U1001 is coupled through L2305 to a 4.5MHz bandpass filter (BPF) and a 4.5MHz trap. The audio IF output signal from the 4.5MHz bandpass filter is sent to the audio signal processing circuits. The video signal is then applied to buffer transistor Q2305. Next, the audio information is removed from the video signal by the 4.5MHz trap. The video signal is then applied to the base of video inverter/buffer amplifier Q2302. The video signal from the collector of Q2302 is applied to the Sync Separator transistor Q3301. The output of Q3301 is input to the AIU (U3300) and is used for active channel detect.

In the Non-Monitor versions of the CTC 156/157, JC419 (Jumper Cap) is installed and the video signal is routed directly to the luma and chroma processing circuits. In the Monitor versions, JC419 is removed and the video signal from the emitter of Q2302 is routed to the Video Switching circuits (IC U1401). The video switching circuits are discussed in a separate section of this manual. The video signal exits the switching circuits at U1401-3 and re-enters the normal low level video processing path.

The video signal developed at the emitter of Q2302 (or from video switching) is applied to two different circuit areas (the luminance processing and chroma processing circuits). The video signal is routed to the contrast preset control R2719 for input to the luma processing circuits. The output from the wiper is passed through luminance delay line DL2701. The composite video signal is applied to the luminance processing section of IC U1001 at pins 52 and 53.

The video from Q2302-E is also capacitively coupled (via C2401) to the Sync Separator within U1001 at pin 57. The output of the Sync Separator is used in the deflection/video processing section of IC U1001.

The chroma information is obtained by applying the video signal via C2813 to a 3.58MHz bandpass filter consisting of R2813, L2802 and C2813. The 3.58MHz BPF passes the chroma information and removes the luma information. The remaining chroma signal is coupled through C2805 and applied to U1001 at pin 49. The chroma signal can be monitored at TP2801.

Troubleshooting
If the chassis exhibits video problems, check TP2307 for a 2.5-to-3 volt peak-to-peak video waveform. If missing, check U1001-47 for a 2.5-to-3 volt peak-to-peak video waveform. If the video waveform is present at U1001-47, suspect the 4.5 MHz BPF components, the 4.5 MHz trap components, L2305, Q2302 or Q2305. If the video waveform is not present at U1001-47, suspect the tuning/control circuits and the IF/video detector section of U1001.

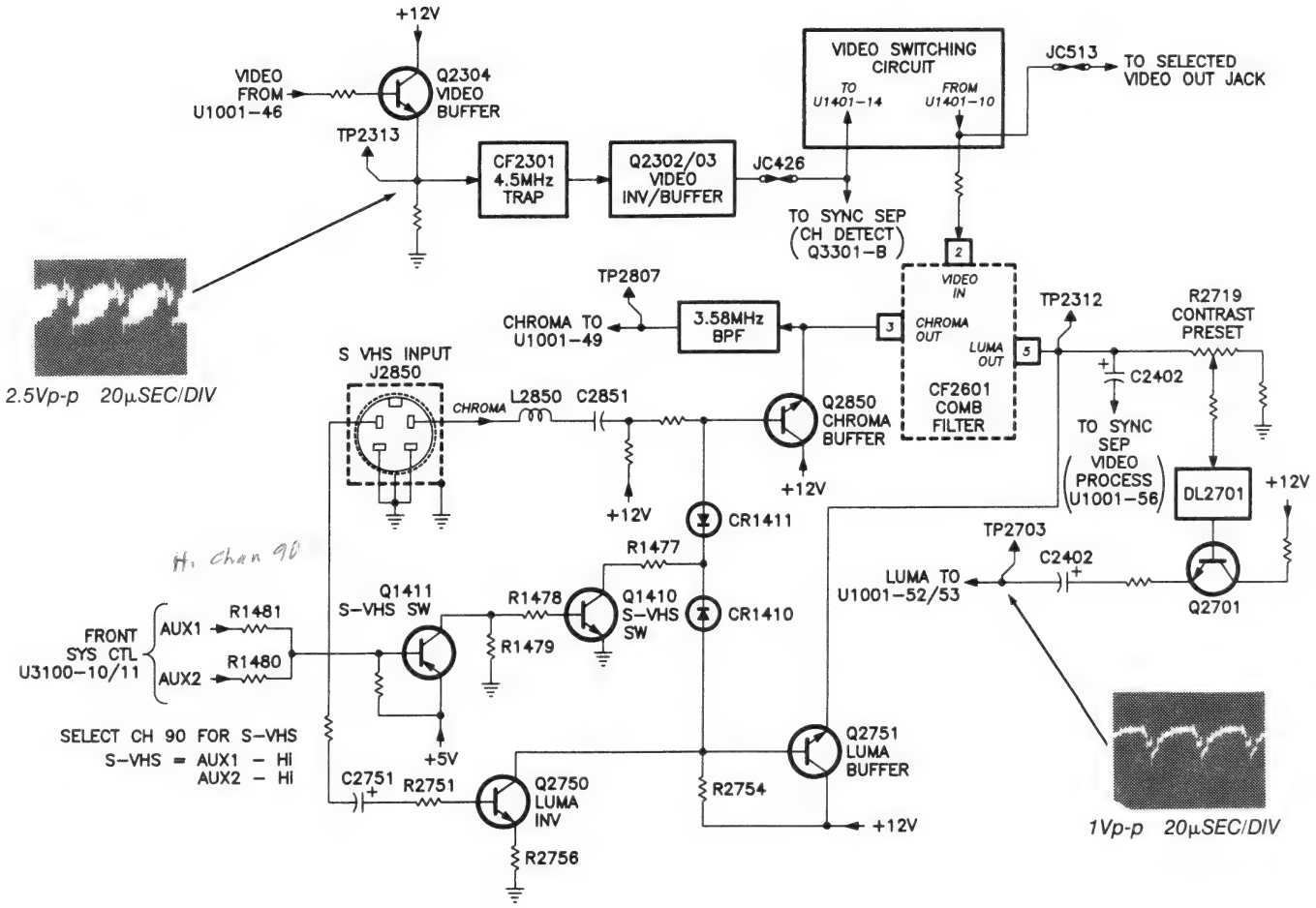
If video is present at TP2307 check:

- Verify operation of video switching circuits. (In Monitor Units)
- U1001-53 for video signal.
- U1001-57 for video signal.
- U1001-49 for a chroma signal greater-than 100 millivolts peak-to-peak with a strong color signal applied (such as a signal generator). Measure the burst level.

If any of these signals is missing, check all the components between the output at U1001-47 and TP2307. If these components check OK, check the luma and chroma processing circuits.

The Step-By-Step procedures listed below are not associated with a particular symptom but are intended for generalized troubleshooting checks. More detailed Symptom–Check procedures are outlined in the preceding text. These procedures are intended to help the technician verify general circuit operation and not necessarily pinpoint specific malfunctions related to a given symptom. The checks listed below are intended only to familiarize the technician with the major test points and signals in a circuit and to provide him with a starting point in his troubleshooting.

1. Check Video @ TP2307.
2. Check Video from U1001-47.
3. Check Output of Q2305 & Q2302.
4. Check Aux Video Switching.
5. Check Chroma @ TP2801.
6. Check Luma @ U1001-52/53.



Low Level Video/S-VHS Input (CTC158/159)

Low Level Video/S-VHS Input (CTC158/159)

The low level video processing circuits of the CTC 158/159 are slightly different than those found in the CTC 156/157. The two major differences are the comb filter (CF2601) and the S-VHS input circuit.

The video signal from U1001-46 if first applied to the video buffer transistor Q2304. The output of Q2304 is next routed through a 4.5MHz (audio sound carrier) trap. After two additional stages of inversion and buffering (Q2302/Q2303) the video is input to the video switching circuit at U1401-14. The video switching circuit is discussed in a separate section of this manual.

The video output from Q2303 is also applied to Sync Separator Q3301-B for channel detect during tuning operation. The output of the video switching circuit (U1401-10) is routed to the selected video out jack and is also applied to the Comb Filter at pin 2 (CF2601).

The comb filter separates the luminance and chrominance signals. The chrominance signal is output at pin 3 of CF2601 while the luminance signal is output at pin 5. The chrominance information is band pass filtered and input to U1001-49 for further processing. The luminance signal is routed through the Contrast Preset (R2719), DL2701 and amplified by Q2701. The luminance output of Q2701 is applied to U1001-52/53 for final processing. The luminance signal present at TP2312 is also capacitively coupled (via C2402) to the Sync Separator section of U1001 and is used for the deflection/video processing.

During *Non S-VHS operation* Q1411 is biased On by its base emitter resistor. With Q1411 turned on, a Hi is applied to the base of NPN transistor Q1410 which turns it On. Whenever Q1410 is turned On, the cathodes of CR1410 and CR1411 are grounded. This forward biases the diodes and turns Off the Chroma buffer Q2850 and Luma Buffer Q2751.

The S-VHS input is controlled (turned On or Off) by the Aux 1 and Aux 2 outputs of the System Control μC U3100-10/11. In order to select the S-VHS input jack (J2850), channel 90 is selected. Whenever channel 90 is selected, both Aux 1 and Aux 2 outputs go Hi. Resistors R1481 and R1480 act as an And gate. This provides a Hi to the base of Q1411 whenever Aux 1 and 2 are Hi. A Hi on the base of Q1411 turns it off thus allowing Q1410 to also turn off. With Q1410 turned off, the forward bias is removed from CR1410 and CR1411 allowing the S-VHS chroma and luminance signals to be input to their respective buffers.

The S-VHS chrominance signal is inserted directly (via Q2850) to the 3.58MHz band pass filter. The S-VHS luminance signal from the input jack is first applied to Q2750 and then to the buffer Q2751. The output of the luma buffer is inserted into the luminance processing path at TP2312. During S-VHS operation the video switching circuits are turned off. Also, the video IF processing portion of U1001 is turned off to prevent any unwanted video information from reaching the signal processing circuits.

Troubleshooting

Some major symptoms associated with a malfunction in the Low Level Video/S-VHS Input circuits in the CTC 159 would appear as listed below but are not limited to:

- No Tuner Video (S-VHS/Aux Video OK)
- No Tuner or Aux Video (S-VHS OK)
- No S-VHS Operation (Tuner/Aux Video OK).
- No Chroma/Luma OK (S-VHS)
- No Luma/Chroma OK (S-VHS)

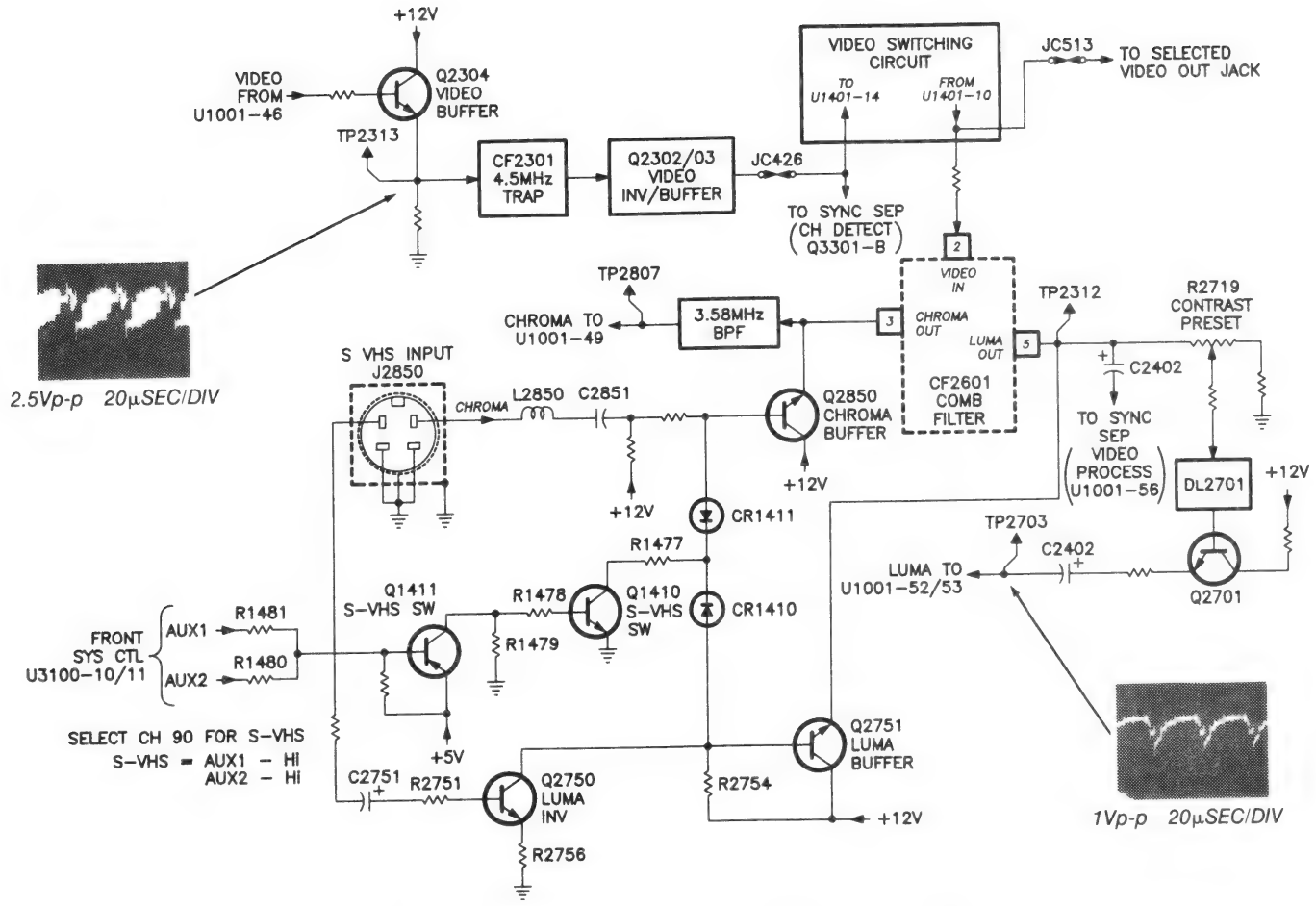
When troubleshooting this circuit it is important to remember that there are three (3) different video sources available. The first is Normal TV Input (from tuner), the second is Auxillary Video Input and third is the S-VHS Video Input. When troubleshooting, it is essential to determine which of the three sources operate normally and which don't. For example, if a No Video symptom is displayed and an auxillary video signal is applied and the instrument operates normally, some important conclusions can be made. First, the video switching circuit is OK. Second, the luma/chroma processing section of U1001 along with the comb filter is operating properly. Third, the problem is most likely located somewhere between the input of the video switching circuit and the output of the tuner. Another example would be TV video and Aux video operation OK, but no S-VHS operation. This type of symptom would indicate that the normal TV video output sources and the U1001 processing circuits and the video switching circuits are OK, and that the problem is most likely located in the S-VHS control circuit or the S-VHS luma/chroma amplifier/buffer devices.

Symptom: No TV Video (S-VHS/Aux Video OK)

1. Check video @ TP2313
   - If not OK check Q2304 and U1001-46
2. Verify video at input of video switching circuit (U1401-14)
   - If not present, check Q2302/Q2303 and 4.5MHz Trap

Symptom: No TV or Aux Video (S-VHS OK)

1. Check video @ TP2313
   - If not OK check Q2304 and U1001-46
2. Verify video at input of video switching circuit (U1401-14)
   - If not present, check Q2302/Q2303 and 4.5MHz Trap
3. Check video at output of video switching circuit. (U1401-10)
   If not present, troubleshoot video switching circuit (see video switching in this manual).
4. Check Chroma/Luma outputs of comb filter.



Low Level Video/S-VHS Input (CTC158/159)

Symptom: No S-VHS Operation (TV/Aux Video OK).

1. Check S-VHS source.
2. Select channel 90 and check Aux 1 and 2 outputs of U3100-10/11.
3. Check S-VHS switches Q1411, Q1410 and diodes CR1411 and CR1410.

Symptom: No Chroma/Luma OK (S-VHS)

1. Check chroma source.
2. Check Q2850, C2851, CR1411

Symptom: No Luma/Chroma OK (S-VHS)

1. Check luma source.
2. Check Q2750, Q2751, C2751, CR1410

The Step-By-Step procedures listed below are not associated with a particular symptom but are intended for generalized troubleshooting checks. More detailed Symptom–Check procedures are outlined in the preceding text. These procedures are intended to help the technician verify general circuit operation and not necessarily pinpoint specific malfunctions related to a given symptom. The checks listed below are intended only to familiarize the technician with the major test points and signals in a circuit and to provide him with a starting point in his troubleshooting.

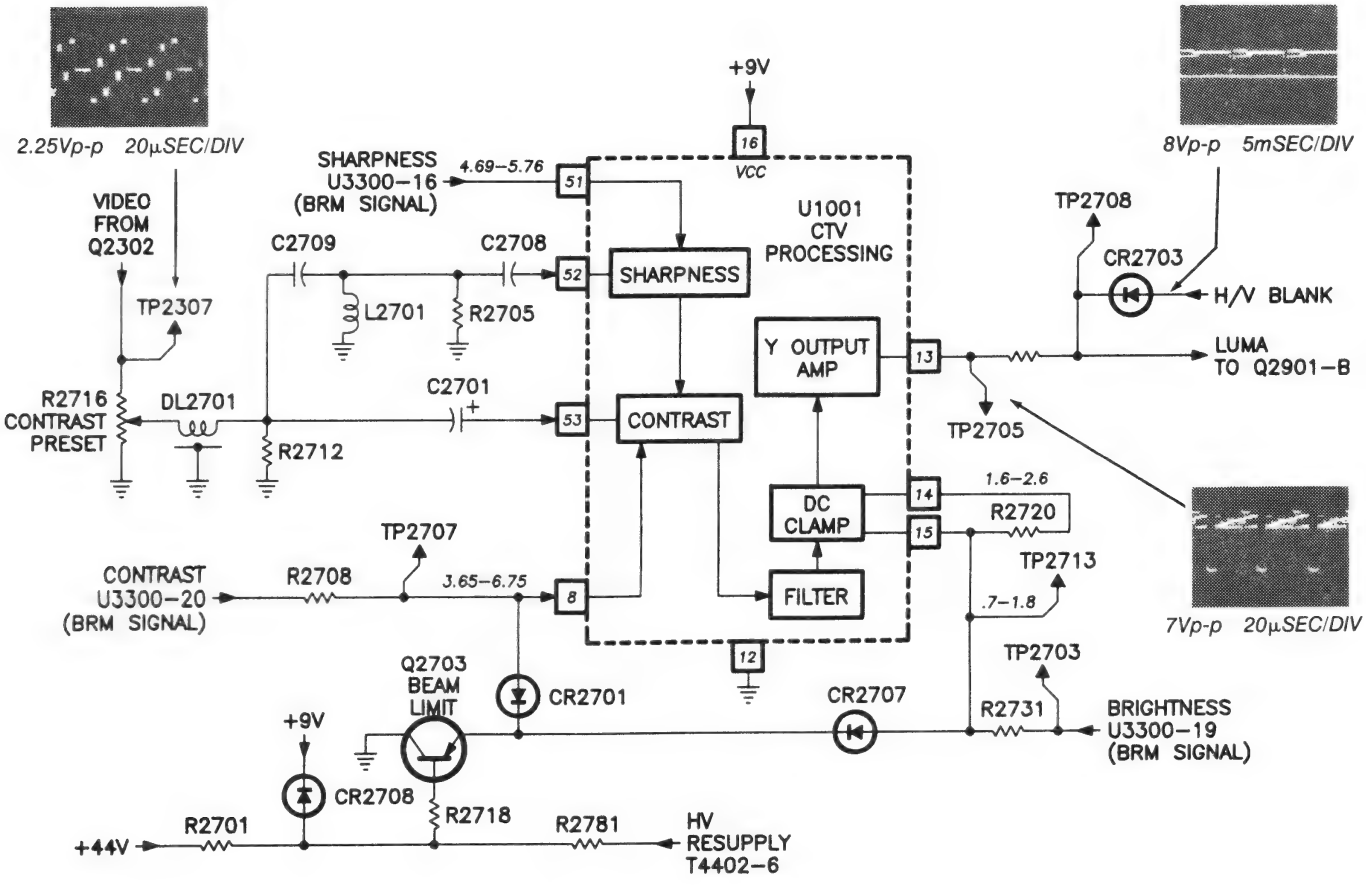
1. Check Video from U1001-46.
2. Check Outputs of Q2302 & Q2303.
3. Check Output of Aux Video Switching.
4. Check Output of Comb Filter.
5. Check Aux 1/Aux 2 (S-VHS Control)
6. Check S-VHS Switches Q1411/Q1410.
7. Check S-VHS Luma Inv/Buffer (Q2750/51)
8. Check S-VHS Chroma Buffer (Q2850).

Luminance Processing (CTC156/157)

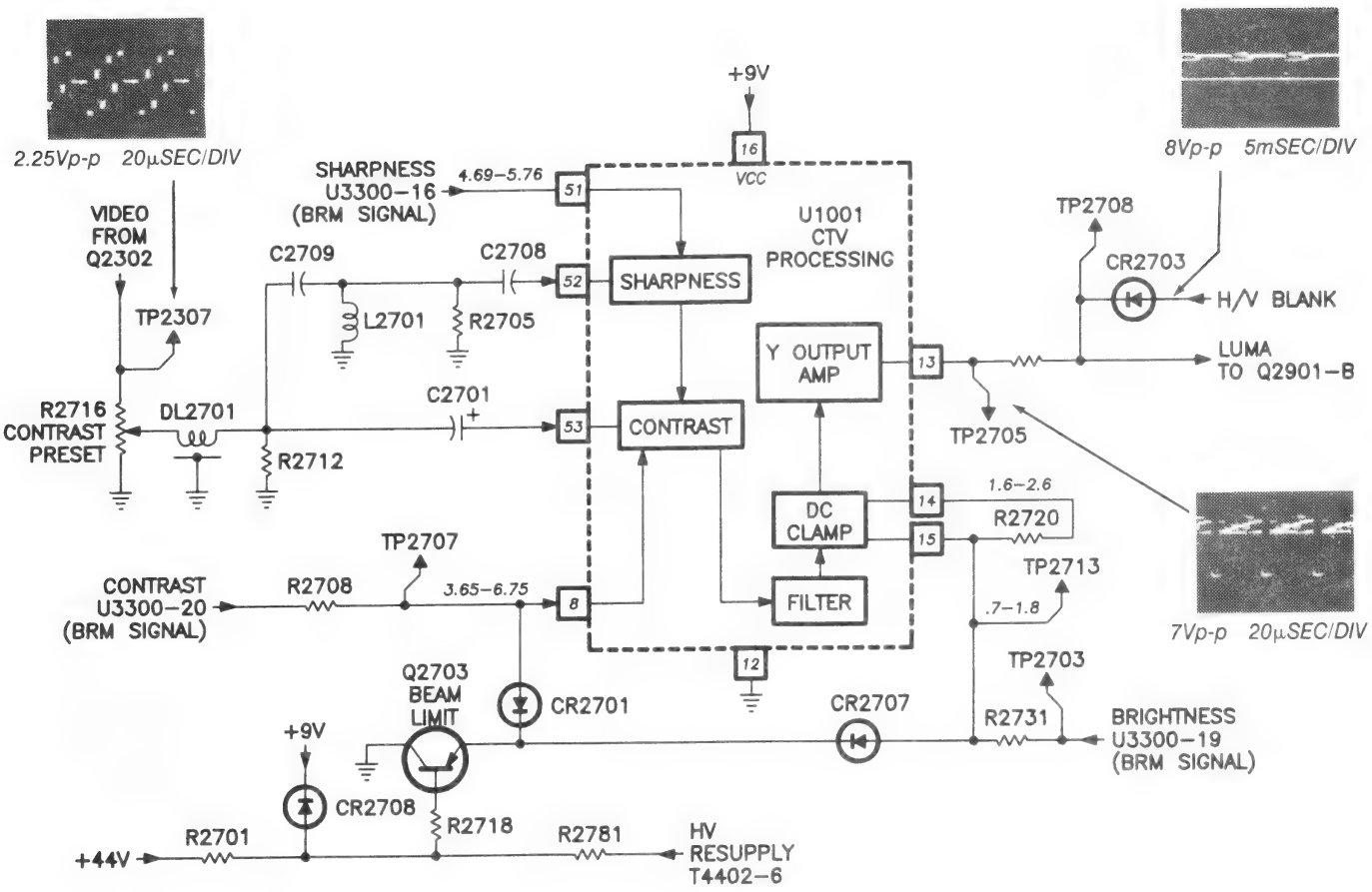
Video from the video buffer transistor Q2302 is first applied to the Contrast Preset control R2716. The video signal from the contrast preset control is then input to a phase compensation delay line (DL2701). Next, the signal is divides into two (2) paths. The high frequency component of the video signal is sent to the sharpness circuit in U1001 at pin 52 while the low frequency portion of the signal is input to pin 53 and applied to the contrast circuit in U1001. The gain of the sharpness circuit is controlled by a DC voltage applied to U1001-51. The DC voltage is produced by filtering the digital sharpness control signal (BRM) output from U3300-16. The high frequency luminance output of the sharpness circuit is input to the contrast circuit. This circuit consists of a variable gain amplifier with the gain controlled by the DC voltage input at pin 8. Again, the contrast control voltage comes from the digital contrast control output (BRM signal) at U3300-20.

The output of the contrast amplifier is filtered and passed to a DC clamp circuit. The clamp is used to set a reference level for the video signal. Another input to the clamp circuit is the brightness control voltage. The brightness control voltage is developed by the AIU (u3300) at pin 19. The DC level varies as the brightness and contrast control voltages are varied.

The system control generates an on-screen display menu so that the brightness, sharpness and contrast adjustments can be monitored. Remote control of these customer video adjustments is also provided in remote models. A picture reset function is also provided in order that the customer may automatically reset the video controls to his own preferred settings or to the factory presets.



U1001 Luminance Processing (CTC156/157)



U1001 Luminance Processing (CTC156/157)

The luminance signal from the DC clamp is applied to the luma output amplifier ("Y" Output) and exits U1001 at pin 13. The vertical and horizontal blanking signals are added to the luma signal via CR2703. The luminance signal is next applied to luminance buffer Q2901. The luminance information is then matrixed with the output of the chroma circuit at the CRT Driver/Bias transistors.

The horizontal blanking signal also serves as an input to U1001-13. The horizontal blanking signal is used inside U1001 as a timing reference signal in the luma and chroma circuits. Several problems can occur if the horizontal blanking signal is missing or of insufficient amplitude. Both the luma and chroma circuits can be affected.

The vertical blanking signal will continue to be output from U1001-13 if the vertical countdown circuit in U1001 is operating. Both the horizontal and vertical blanking signals should be positive pulses with a peak voltage of approximately 9 volts.

The sync signal for the deflection circuits of U1001 are also produced in the luma processing section. Generation of this sync signal is required for proper operation of the deflection and chroma circuits in U1001. The operation of the sync separator in the luma circuit can be tested at the Tint control input of U1001. Negative-going composite sync pulses will be present riding on the DC control voltage. The sync tips should be near ground.

Beam Limiter Circuit Operation

The purpose of the beam limiter circuit is to reduce the amount of drive to the CRT when a predetermined level of beam current is exceeded. The beam limiter circuit is tied to the brightness and contrast control lines. The beam limiter circuit overrides the contrast and brightness settings generated by U3300 during periods when the beam current exceeds a predetermined level. As the beam current rises, the HV Resupply voltage from T4402-6 begins to fall. This causes the base voltage of Q2703 to go down. As the base voltage of Q2703 falls, the transistor turns on harder and pulls down or limits the contrast and brightness voltages at pins 8 and 15. The point at which the Beam Limit circuit starts to override the contrast and brightness control voltages are determined by the values of R2701, R2718 and R2781.

As the beam current increases, the voltage at the anode of CR2708 decreases. When the voltage decreases to about 4.7 volts, the first stage of beam limiting occurs. Transistor Q2703 begins to conduct and the voltage at pin 8 of U1001 is pulled down via CR2701. This action limits the contrast (and beam current) and allows the contrast to track the incoming signal. At this point, diode CR2707 is still reverse biased because the maximum brightness control voltage is about 2 volts.

If the beam current continues to increase, the voltage at the anode of CR2708 continues to decrease and CR2707 becomes forward biased and begins to conduct reducing the brightness control voltage applied to U1001-15. This causes the voltage at pin 8 of U1001 to stay fixed at approximately +5.0 volts, limiting the contrast and the brightness.

Troubleshooting

First confirm the proper input video signal at pin 53 (0.7 Vp-p) and then check for the luminance output and horizontal blanking input at pin 13. If all signals are present, check the CRT driver/bias stages. If the blanking signal is missing, check the blanking circuit. If the video output signal is missing and the input to pin 53 and horizontal blanking signal are good, check the brightness, contrast, and sharpness control voltages while varying the control settings. Also check the DC clamp voltage at pin 14. Typical voltage ranges are shown in the simplified diagram. These voltages are typical only and should not be considered the exact values. The voltages will vary slightly between instruments.

The DC Clamp voltage varies depending on the brightness and contrast settings. A typical range is 1.6-to-2.6 volts as brightness is run through its range.

If all input signals and control voltages are normal, check B+ (pin 16) and the ground connection at pin 12. If the brightness and contrast control voltages are incorrect, check the control pulse outputs (BRM outputs) and their respective filters at the AIU U3300. If the AIU outputs are normal but the contrast and/or brightness control voltages are incorrect, suspect the beam limiter circuit or U1001. If the brightness and contrast voltages are normal but the clamp voltage is incorrect or does not change when the brightness voltage changes, suspect U1001.

The Step-By-Step procedures listed below are not associated with a particular symptom but are intended for generalized troubleshooting checks. More detailed Symptom–Check procedures are outlined in the preceding text. These procedures are intended to help the technician verify general circuit operation and not necessarily pinpoint specific malfunctions related to a given symptom. The checks listed below are intended only to familiarize the technician with the major test points and signals in a circuit and to provide him with a starting point in his troubleshooting.

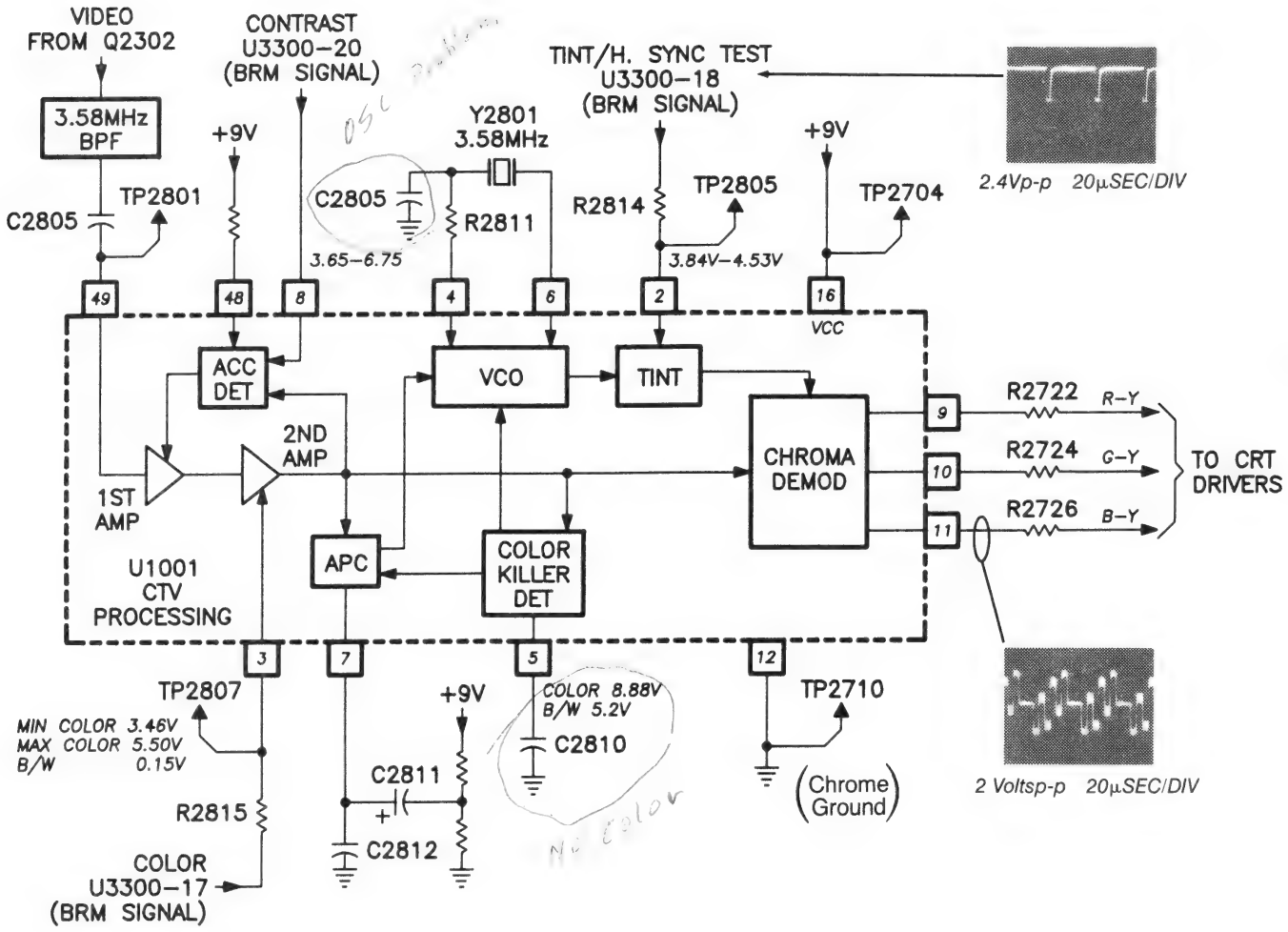
1. Check Video @ TP2307.
2. Check Video @ U1001-52/53.
3. Check Luma @ TP2705
4. Check Blanking Input (TP2708).
5. Check Contrast/Bright/DC Clamp.
6. Check Beam Limit Circuit.

Chrominance Processing (CTC156/157)

The composite video signal from Q2302 is applied to a 3.58 MHz bandpass filter (BPF). The output of the filter is the chroma information. The chroma signal is input to IC1001 at pin 49 and may be checked at TP2801. The signal is applied to the first (1st) chroma amplifier. The gain of this stage is controlled by an Automatic Color Control (ACC) circuit that is similar to an automatic gain control. The contrast control voltage, from the luma processing section (U1001-8), is also input to the ACC detector so that the color level tracks the luma level.

The Sync Test output of U1001 is the Tint control voltage input at pin 2 of U1001. The horizontal blanking signal may be checked at the luma output (U1001-13). Refer to the luminance processing section of this manual for details.

The output of the first chroma amplifier is passed to the second (2nd) chroma amplifier. The gain of the second chroma amplifier is determined by the Color Control voltage (DC) developed from BRM (Bianary Rate Multiplier) signals produced by the AIU (U3300). The second chroma amplifier stage also has an input from the



U1001 Chroma Processing (CTC156/157)

color killer detector. When a monochrome signal (Black & White) or a signal with poor/weak color information is received, the color killer circuit activates, turning the second chroma amplifier off and grounding the color control voltage input at pin 3. When a good clean color signal is received, the color killer is turned off and the output of the second chroma amplifier is passed to the demodulator.

In order to demodulate the chroma signal, a 3.58MHz Voltage Controlled Oscillator (VCO) is used. The frequency of the oscillator is controlled by crystal Y2801. The crystal (3.58MHz) for the oscillator circuit is connected between pins 4 and 6. The Automatic Phase Control circuit (APC) compares the phase of the VCO signal to the color burst signal and generates a phase error signal. The phase error signal is used to keep the phase of the VCO locked to the burst signal.

The APC circuit has an automatic search function, that is activated when the color killer is turned on. As the APC circuit is searching for color burst, a sawtooth waveform appears at pin 7. The waveform is approximately 1.2Vp-p with a period of about 140mSec. The output of the VCO is applied to the Tint control circuit. The DC tint control voltage is derived from the digital output of U3300-18. The output of the tint control circuit is applied to the demodulator circuit. The demodulator uses this signal as well as the output from the second chroma amplifier to develop the R-Y, G-Y, and B-Y signals. The resulting color difference signals are routed to the CRT board where they are matrixed with the luma signal.

Chroma Troubleshooting

Proper black and white operation should be verified before attempting to diagnose and troubleshoot a chroma malfunction. The horizontal blanking signal applied to U1001-13 must be correct (see luminance processing service procedures). The sync separator output must be present at U1001-2. All of the preceding conditions must be met or the chroma processing circuit cannot operate correctly. The blanking and sync signals are used to internally generate (inside U1001) the sandcastle pulse and burst gate pulse required by the chroma processing circuit.

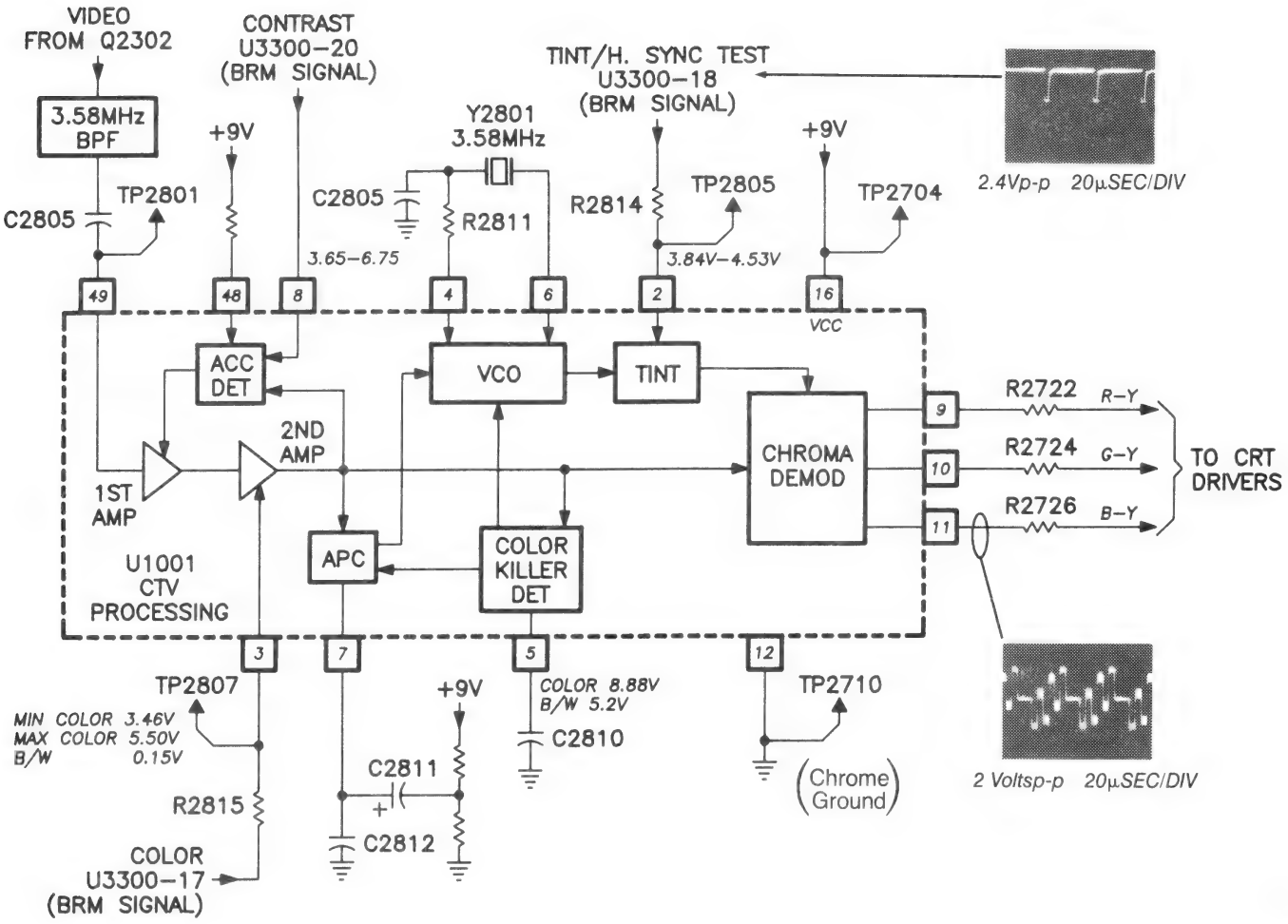
The sync signal at pin 2 is a negative-going composite signal of approximately 4Vp-p. Pin 2 is self-biased to approximately +4volts and continues to produce the sync output, even if U3300 fails or the pull-up connection to the +9-volt supply opens. However, tint control is lost if U3300 fails or the +9-volt pull-up opens. The sync separator output from U1001 is buffered and the chroma processing circuit will continue to operate (without tint control) when pin 2 is externally grounded because the internal sync connection of U1001 is not affected.

Chroma malfunctions are sometimes difficult to troubleshoot because of the interaction between the different stages of the chroma circuits. For ease of troubleshooting, connect an RF color-bar signal generator to the antenna input of the TV receiver. The amplitude of the color signal at pin 49 should be approximately 100-200mVp-p. If the chroma signal is not present at pin 49, check the low level video processing circuit and the 3.58MHz bandpass filter components.

The ACC detector measures the strength of the chroma signal and develops the ACC control voltage. The ACC control voltage can be measured at U1001-48. This should be a steady DC voltage (without ripple or pulses) about 7.6 to 7.7 volts with normal chroma input. A voltage of about 8.5 volts indicates that the amplitude of the chroma signal is low or that the ACC detector in U1001 is not operating properly.

If the pull-up resistor connected to pin 48 is open or the connection to the +9-volt supply is open, the voltage at pin 48 falls to approximately +7.15 volts and results in weak or missing color. The symptom of weak or missing color can vary depending on the strength of the color signal and the setting of the color control.

The APC, VCO, and Color Killer Detector circuits in U1001 interact considerably. However, the ACC voltage will be correct if the chroma input to U1001 is good, even if a defect in one of these stage causes a no-chroma symptom. Most defects, in any of these stages, will cause symptoms that are the same or very similar. Regardless of the stage that is defective.



U1001 Chroma Processing (CTC156/157)

To confirm operation of chroma processing sections of U1001, perform the following checks (measure average DC level with a multimeter):

- Check the 3.58MHz VCO output.
  Pin 4 - Approx. 1 Vp-p peaked sine wave with an average DC level of about +5.7 volts.
  Pin 6 - Approx. 180 mVp-p sine wave with an average DC level of +2.4 volts.
- Check the color killer detector level at pin 5.
  The color killer becomes active when the voltage at pin 5 drops to about 5.5 volts. With a strong color-bar signal from the signal generator, the color killer voltage should be free from ripple and greater than +8.4 volts DC.
- Check the APC voltage at pin 7.
  This voltage should be steady at about +3.6 Volts DC.
- Check the color control voltage.
  The typical voltage range at pin 3 should fall within the range of +3.5 volts DC (minimum color) to +5.5 volts DC (maximum color). If the voltage at pin 3 is near ground (approx. +0.15 volts DC), the color killer is active and pin 3 has been grounded inside U1001.

When a defect occurs in the APC, VCO, or Color Killer circuits, U1001 is unable to lock to the incoming color burst signal. If there is no color information input to U1001-49 or a defect prevents U1001 from locking up to the burst, U1001 hunts or searches for the burst signal. During this hunting or searching, the symptom on the screen is no chroma or intermittent (flickering) chroma.

If U1001 is hunting/searching normally the following signals/conditions should be present with a signal input:

- A 1.2Vp-p, 140mSec sawtooth waveform (riding on about +3 volts DC) will be generated at U1001-7.
- The voltage at U1001-5 is less-than +5.5 volts and stable.
- The peak-to-peak voltages of the VCO waveforms (pins 4 and 6) pulse at the same rate as the waveform at U1001-7.
- The color control voltage at U1001-3 should be near ground (approx. +0.15 volts DC) because the color killer circuit grounds pin 3 inside U1001.

Check the following list of electrical symptoms to help determine the failed component(s):

APC Circuit

- No sawtooth waveform at U1001-7;

Noise present	C2811 or C2812 open.
grt-than +4 VDC	Open ground resistor (R2810) to C2811 negative lead.
approx. +3.6 VDC	C2811 shorted.
Less-than +3.6 VDC	C2812 shorted.

- Sawtooth waveform present at U1001-7.
  If the voltage at the negative lead of C2811 is: less-than +3.4 VDC, suspect an open or high resistance +9 volt pull-up resistor (R2809). If the voltage is approx. +3.6 VDC, check the color killer circuit and the FSC VCO.

Color Killer

- Unstable voltage at U1001-5:

5 Vp-p spikes (1H)	C2811, pin 5, or ground connection open.
0.5 Vp-p ripple	Normal hunting or defect in APC or FSC VCO.

VCO

- No 3.58 MHz FSC at U1001 pins 4 and 6:

DC bias normal	Y2801 or R2811 open.
140mSec sawtooth @ Pin 4	Y2801 shorted.

- 3.58 MHz FSC present at U1001-4, but waveform is unusually modulated at 140 mSec rate:
  C2813, C2814, or R2812 open.

If none of the symptoms are present and color is missing or flickering, suspect U1001.

To confirm operation of the tint control, chroma demodulator, and output stages of U1001:

- Measure the DC voltage at U1001 pins 9, 10, and 11 with no signal applied. The voltage should be +5.4 +/− 0.4 VDC. The voltage at each pin should be nearly the same (within 0.1 volts).
- Apply a color-bar signal and check the waveforms present at U1001 pins 9, 10, and 11 with an oscilloscope. The waveforms should be similar to those shown in Service Data. The peak-to-peak voltage of these waveforms should change as the color control setting is varied. The phase (shape) of the waveforms should change as the tint control setting is varied.

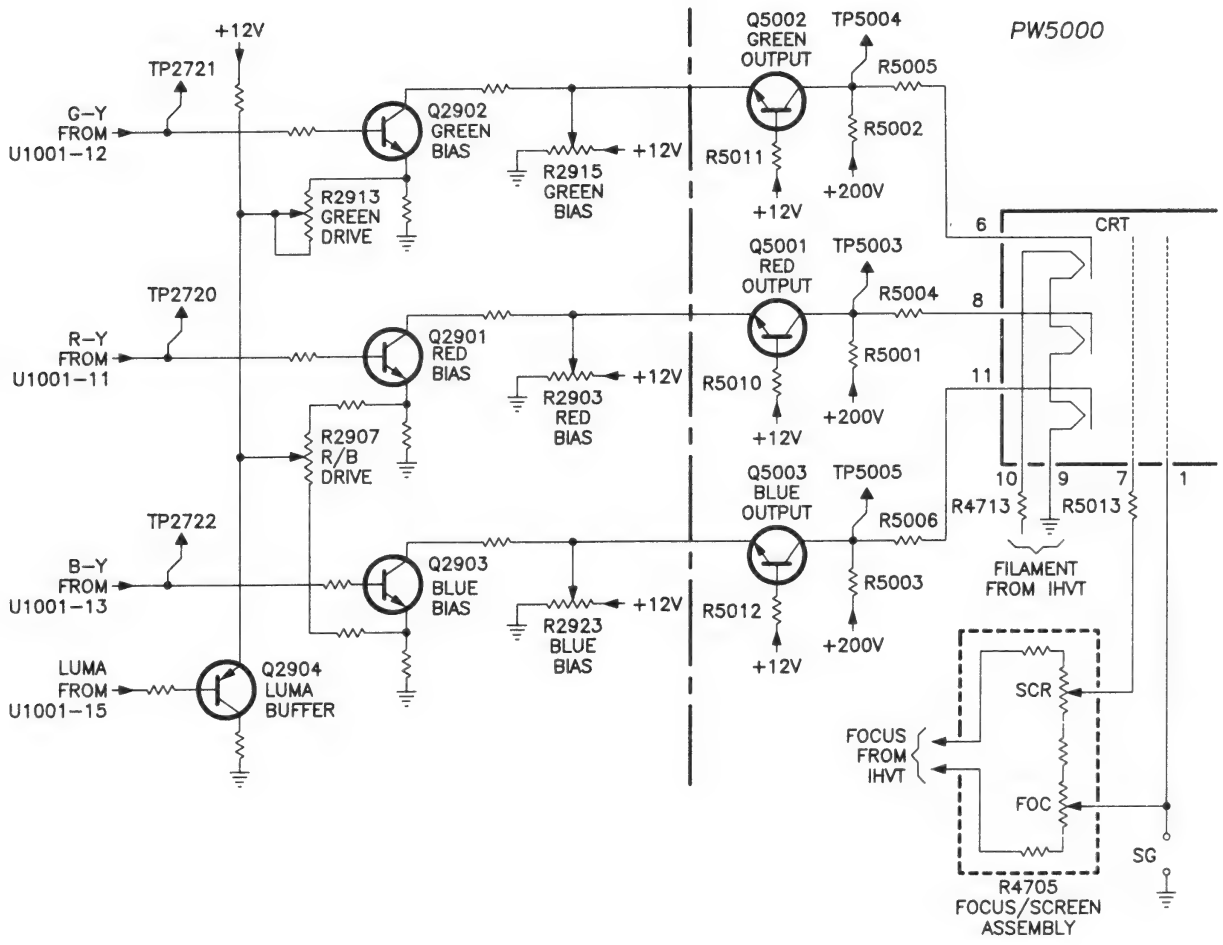
If the bias voltages at pins 9, 10, and 11 are incorrect, unsolder R2722, R2724, and R2726. Then check the bias voltages again. If the voltages are incorrect, suspect U1001. If the voltages are correct, suspect the CRT Driver/Bias circuits.

If the tint control does not have the proper effect, check the Tint control voltage at U1001-2. The typical voltage range at pin 2 should fall within the range of +3.8 volts DC (red tint) to +4.5 volts DC (green tint). The voltage range at pin 2 is also affected by the Tint Preset control (R3335) in the system control circuit.

If the Tint control voltage is correct, suspect U1001. If the Tint control voltage is incorrect, unsolder pin 2 and check the voltage at R2814. If the voltage can now be varied at least five volts (+0.5 volts to +5.5 volts), suspect U1001. If the voltage does not vary at least five volts, suspect the Tint control circuit associated with U3300.

The Step-By-Step procedures listed below are not associated with a particular symptom but are intended for generalized troubleshooting checks. More detailed Symptom–Check procedures are outlined in the preceding text. These procedures are intended to help the technician verify general circuit operation and not necessarily pinpoint specific malfunctions related to a given symptom. The checks listed below are intended only to familiarize the technician with the major test points and signals in a circuit and to provide him with a starting point in his troubleshooting.

1. Check H.Sync Test (TP2805).
   - DC level & Waveform
2. Check Chroma @ TP2801.
3. Check R-Y/B-Y/G-Y.
4. Check Contrast Control @ U1001-8.
5. Check Color Control @ TP2807.
6. Check Color Killer (U1001-5).



CRT Bias and Driver Circuit (CTC158/159)

CRT Bias and Driver Operation

The G-Y, R-Y and B-Y color difference signals from CTV Processor IC U1001 are output at pins 11, 12 and 13. These color signals are first applied to the base of the three bias transistors Q2901, Q2902 and Q2903. The Luminance information is output at pin 15 of IC U1001 and is applied to the Luma Buffer transistor Q2904. The output of the buffer transistor is then applied to R2913 (Green Drive) and R2907 (R/B Drive). These controls are connected to the emitters of the bias transistors and allow the luminance information to be added to the demodulated chroma signals. The signals that are output at the collector of the bias transistors is the R, B and G drive signals and are input to the emitters of their respective CRT output drive transistors on the PW 5000 circuit board. The CRT output drive transistor stages are operated in a common base configuration. The output signal from the collectors of the drive stages are connected to the red, green and blue cathodes inside the CRT.

Troubleshooting

There are three (3) major symptoms associated with the CRT Bias and Drive circuits. These are Color only in the picture (No Luminance), excessive color (luminance OK) and missing one or more colors in the picture. A failure that displays a "Color Only" symptom (No Luma) is very likely caused by a failure of the Luma Buffer Q2904 or its associated components (R2907/R2913). However, if the Luma Buffer and its components check OK, insure that luminance output from the CTV Processor U1001-15 OK.

An excessive amount of one color in the picture can be caused by two possible failures. The most likely failure is a collector/emitter short of a CRT output transistor or a shorted bias transistor. If this occurs, the predominate color gun will be fully "On" causing an excess of that color. To check for shorted drive transistor, turn Brightness, Contrast, and Color controls to minimum and measure the collector voltage. The collector voltage should be approximately 200 volts. If less than 180 or 190 volts, suspect a shorted CRT output transistor or shorted bias transistor.

Power for the heating filaments of the CRT guns are supplied by an auxiliary winding in the IHVT. The screen grid potential is derived from an integral Focus and Screen control divider assembly, R4705, which is mounted on the IHVT. The focus voltage to the CRT is derived from the same voltage divider as the screen potential. The wiper of the focus control is connected to a 10-kV spark gap.

In order to maintain the correct DC bias to the cathodes of the CRT, Bias Controls R2915, R2903 and R2923 are used in the collector of each bias transistor. The adjustment of these controls compensates for the variations in the DC characteristics of the CRT driver transistors and the CRT. Correct adjustment of the bias controls maintains the proper low-light white balance of the picture.

The drive controls, R2907 and R2913, are used in the emitters of the bias stages to compensate for the variations in the gain of the stages. The luminance signal from R2907 (R/B Drive Adj.) is applied to the emitters of both the Red Bias (Q2901) and the Blue Bias (Q2903). By varying the control (R2907), the amount of luminance signal to each bias transistor is changed, balancing the red and blue high-lights. The amount of luminance signal applied to the emitter of Q2902 is determined by R2913. The green drive control is adjusted for proper high-lights white balancing after the red and blue drive has been set.

The lack of one color in the picture can be caused by an open output driver transistor, open picture tube cathode circuit, or an open bias transistor. Adjust the Brightness, Contrast, and Color controls to maximum and measure the collector voltage of the CRT Output Driver transistors. The collector voltage of the output transistors should be approximately 110 Volts DC. If the voltage of any one of the driver transistors is approximately 200 volts, suspect either an open CRT output transistor or bias transistor.

The Step-By-Step procedures listed below are not associated with a particular symptom but are intended for generalized troubleshooting checks. More detailed Symptom–Check procedures are outlined in the preceding text. These procedures are intended to help the technician verify general circuit operation and not necessarily pinpoint specific malfunctions related to a given symptom. The checks listed below are intended only to familiarize the technician with the major test points and signals in a circuit and to provide him with a starting point in his troubleshooting.

1. Check G-Y/R-Y/B-Y.
2. Check Luma (U1001-15 & Q2904).
3. Check Output of Q2901/02/03.
4. Check TP5003/4/5 (DC Bias).

On-Screen-Display

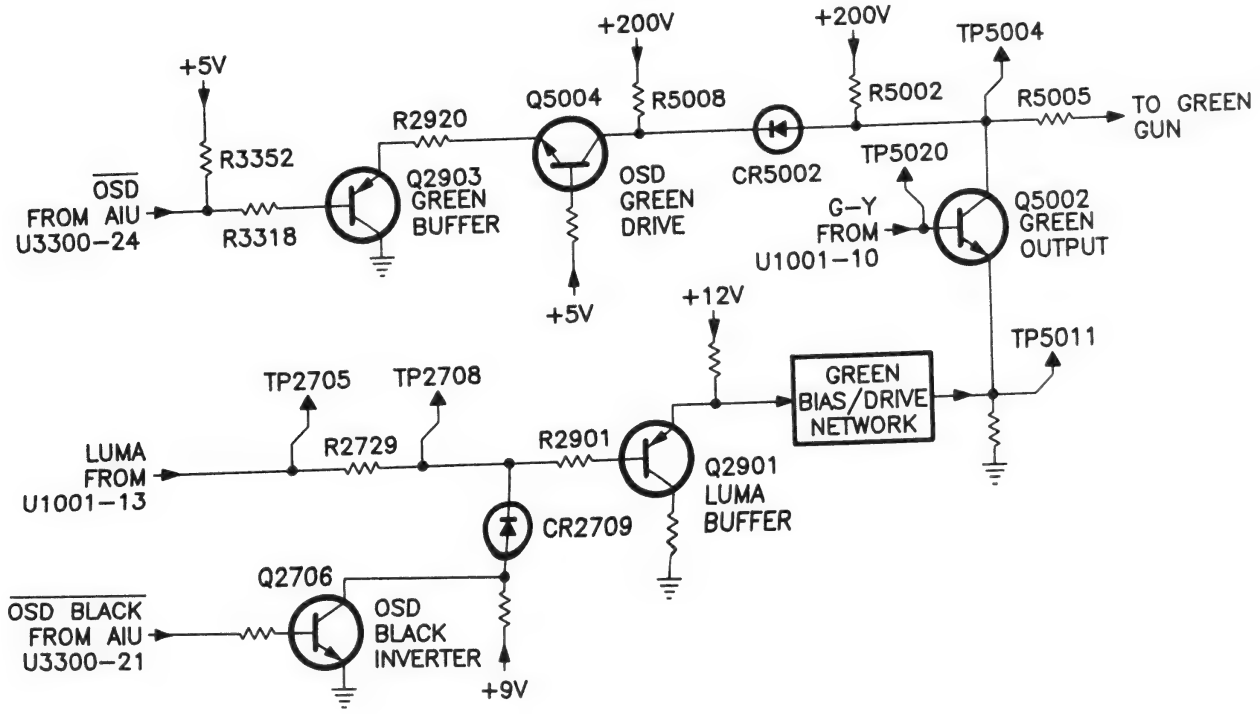
CTC156/157 OSD Operation

The CTC 156/157 OSD (On-Screen-Display) information is generated by the AIU (U3300). However, it should be remembered that the System Control μC U3100 instructs the AIU to output the OSD signals. The $\overline{\text{OSD}}$ information is inserted into the chrominance path while the black edge information is input directly into the luminance path. The $\overline{\text{OSD}}$ information is output from pin 24 of U3300 and applied to the base of the green buffer (Q2903). The black edge signal around the OSD is also generated by the AIU and is output at pin 21. The $\overline{\text{OSD}}$ and the $\overline{\text{OSD Black}}$ output signals from the AIU (U3300) are inserted into the signal path at the necessary horizontal and vertical rate in order to generate the OSD in the desired location on the CRT.

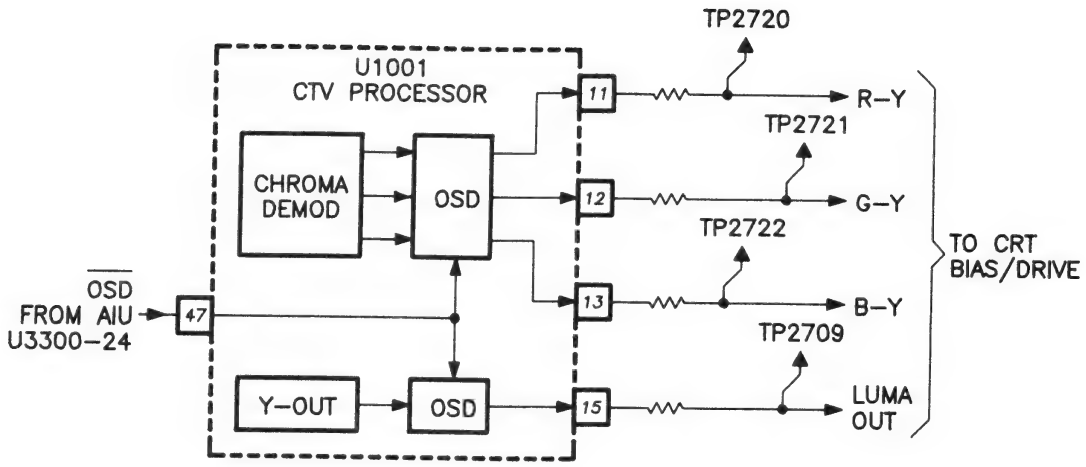
During normal operation (Non-OSD operation) the luminance information (inverted) is output from IC U1001-13 and applied to the base of Q2901. The output of Q2901 is then mixed at the emitter of Q5002 with the chroma information that is input to the base of Q5002. The output of Q5002 (collector) drives the green gun of the CRT.

In order to generate a "Green" character for the on screen display it is necessary to force the green gun into a "Saturated" or "Full On" condition. This is accomplished by Q2903 and Q5004. The Green Buffer (Q2920) is normally biased Off by the +5V across R3352/R3318. When the OSD (active Lo) is applied to Q2903, the base is pulled Lo enough for Q2903 to turn On. With Q2903 On, Q5004 also turns On. With Q5004 turned on its collector is pulled down close to ground and causes CR5002 to become forward biased. With CR5002 forward biased, the collector of Q5002 (connected to the green gun via R5005) is pulled Lo even though there may not be any G-Y signal to its base. The current path for the green gun is now supplied by Q5004 instead of Q5002. Q5004 operates in a saturated mode while the current thru Q5002 is control by the amount of G-Y signal applied to its base.

The generation of the black edge around the OSD characters is similar in concept to the generation of the OSD character itself except that the luminance signal is turned completely Off instead of forcing it into saturation as was done with the chrominance signal. The $\overline{\text{OSD Black}}$ signal (again active Lo) is input to the base of Q2706. Q2706 is biased normally On thus causing CR2709 to be reversed biased. With CR2709 reversed biased the luminance path is uneffected. However, when the $\overline{\text{OSD Black}}$ signal goes Lo, Q2706 turns Off. With Q2706 off, the +9V is coupled across CR2709 to the base of Q2901. Since Q2901 is a PNP, if the base is pulled Hi it is turned Off. During normal operation, the



OSD Generation (CTC156/157)



OSD Generation (CTC158/159)

inverted (negative going) luminance signal from U1001-13 is applied to the base of the luma buffer Q2901. The luma buffer is biased very close to cut-off and when the negative going luminance signal is applied to its base it turns on and passes the signal. However, when Q2706 turns off and the +9V is applied to the base of Q2901, the luminance signal is unable to turn Q2901 on. With Q2901 forced off, the luminance portion of the green drive signal is removed. This causes the black edge to appear around the green OSD character.

CTC158/159 OSD Operation

The operation of the OSD (On-Screen-Display) in the CTC 158/159 chassis is somewhat simpler than that found in the CTC 156/157. The $\overline{\text{OSD}}$ signal is still output from the AIU (U3300) from pin 24, however, there is no OSD Black edge signal. This is provided for internally within U1001. The $\overline{\text{OSD}}$ signal is input directly into the CTV Processor U1001 at pin 47 and is applied directly to the outputs of the chroma demod section and Y-Out amplifier. From a troubleshooting standpoint, the CTC 158/159 is easier to repair. Simply check the output of the AIU at pin 24 for the $\overline{\text{OSD}}$ signal. If the $\overline{\text{OSD}}$ signal is OK, suspect the CTV Processor U1001. If the $\overline{\text{OSD}}$ signal is not present, insure that the System Control μC has instructed the AIU to output the $\overline{\text{OSD}}$ signal. Also, the System Control μC could also cause a symptom such as a scrambled OSD.

OSD Troubleshooting (CTC156/157)

Symptoms associated with a failure in the CTC156/157 OSD circuit are listed below:

No OSD or Improper (scrambled) OSD
No Green OSD character
No Black Edge
Solid Green Screen
No Luminance (Chroma OK)

Symptom: No or Improper (scrambled) OSD

1. Check $\overline{\text{OSD}}$ and $\overline{\text{OSD Black}}$ outputs of U3300-21/24
2. Check for Control Data output from System Control μC when display is selected.
   - If control data present but OSD is scrambled, suspect U3300 or U3100.

Symptom: No Green OSD character

1. Check $\overline{\text{OSD}}$ output from U3300-24
2. If OK, check Q2903, Q5004 and CR5002.

Symptom: No Black Edge

1. Check $\overline{\text{OSD Black}}$ output from U3300-21.
2. If OK, check Q2706 and CR2709.

Symptom: Solid Green Screen

1. Check output of U3300-24.
   If pulled Lo, suspect U3300.
   If OK, check for shorted Q2903 or Q5004.
   If Q2903/Q5004 check OK, suspect Green drive problem or chroma processing problem.

Symptom: No Luminance (Chroma OK)

1. Check output of U3300-21.
   If pulled Lo, suspect U3300.
   If OK, check for shorted Q2709.
   If Q2709 checks OK, suspect Luminance processing problem or luminance drive problem.

Auxiliary Video-In Switching (CTC158/159)

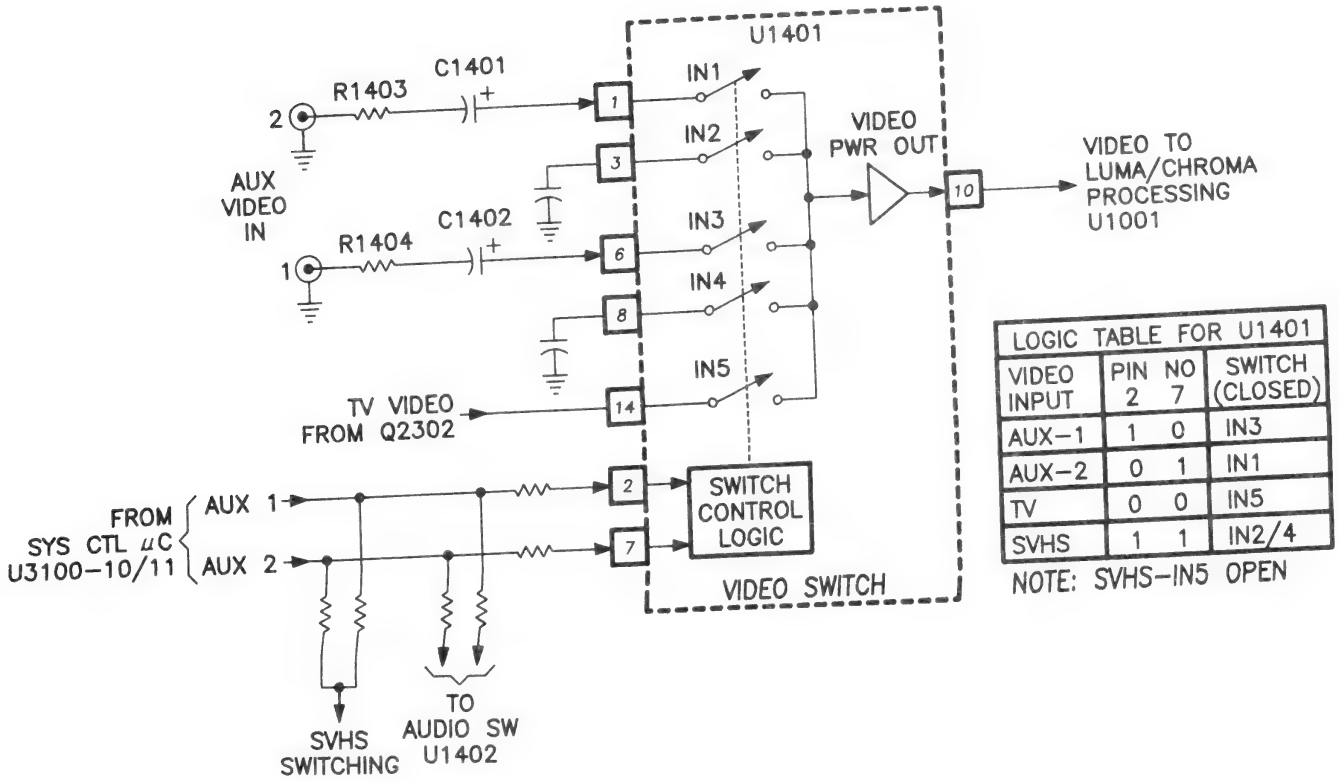
Auxiliary video input switching is provided U1401. There are three (3) inputs to the video switching IC U1402. The Aux 1 and Aux 2 video input and the TV video from Q2302. The SVHS input switching is covered in a separate section of this manual. Aux 1 video is capacitively coupled into U1402 at pin 1 while Aux 2 video is input at pin 6. The Aux 1 and Aux 2 control outputs from the System Control μC U3100-10/11 determine which video input is selected. The digital code that determines which video source is selected is input at pins 2 and pin 7 of U1401 and applied to the Switch Control Logic. The switch control logic closes or opens the appropriate switch depending on which source is selected. Refer to the logic table for U1401 to determine what the code should be at pins 2 and 7. The Aux 1 and Aux 2 output signals from the μC are also applied to the audio switching circuits and to the SVHS switching circuit. Once the video source is selected, the video signal is amplified and exits U1401 at pin 10 and is input to U1001 for further processing.

Troubleshooting

If a video switching malfunction is suspected, check for video at the selected input and also at the output of U1401 at pin 10. Also check that the appropriate code is present at U1401-2/7. See logic table for U1401 for the the correct codes. If the correct code is not present suspect the System Control μC U3100. If the correct code is present and no video output at pin 10 of U1401, suspect the video switch IC U1401.

The Step-By-Step procedures listed below are not associated with a particular symptom but are intended for generalized troubleshooting checks. More detailed Symptom–Check procedures are outlined in the preceding text. These procedures are intended to help the technician verify general circuit operation and not necessarily pinpoint specific malfunctions related to a given symptom. The checks listed below are intended only to familiarize the technician with the major test points and signals in a circuit and to provide him with a starting point in his troubleshooting.

1. Check for Correct Code at U1401-2/7.
2. Check Aux Video In (U1401-1/6).
3. Check TV Video In (U1401-14).
4. Check Aux Video Out (U1401-10).



AUX Video Switching (CTC158/159)

Mono Audio Operation (CTC156/157)

The video signal from U1001-47 is passed through 4.5-MHz bandpass filter CF1201 into the sound IF limiter (SIF) within U1001. The output of the limiter is passed to the sound IF detector. The LC network connected between pins 32 and 33 of U1001 is tuned to 4.5 MHz and is used to recover the audio signal. The audio signal exits U1001 at pin 34 and is capacitively coupled back into U1001 to an electronic attenuator circuit.

The volume control voltage for the attenuator is developed by U3300 and is input to U1001 at pin 30. This DC voltage varies from approximately +1.5 volts (Min Vol) and +4.8 volts (Max Vol). The audio signal is amplified before leaving U1001 at pin 28 (TP1202).

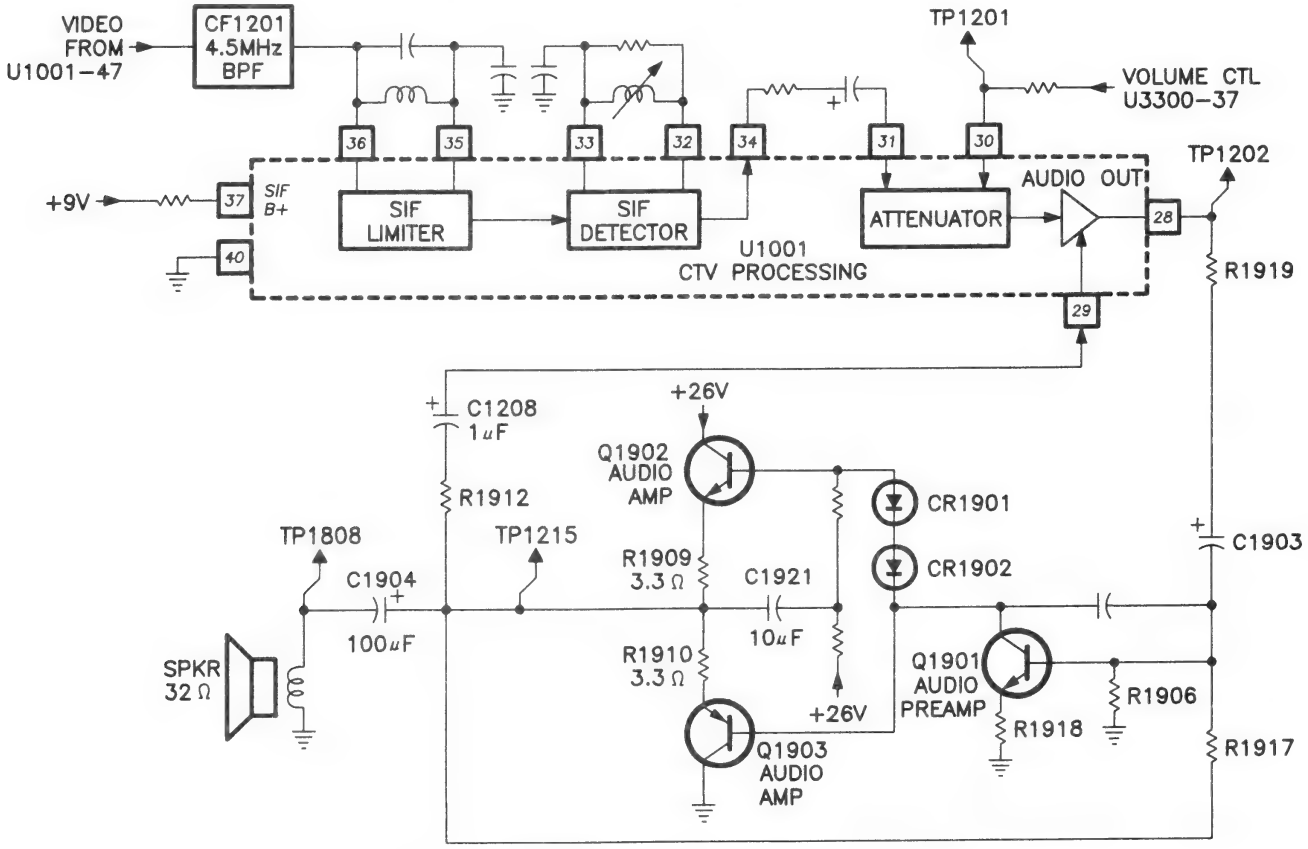
The Mono versions of the CTC156/157 chassis utilizes a discrete audio power amplifier circuit, rather than the familiar audio output IC. The audio signal from U1001 is applied to the base of Audio Preamplifier Transistor Q1901. The signal is amplified and applied to the base of transistors Q1902 and Q1903. Transistors Q1902 and Q1903 form a Push/Pull amplifier. The output of the Push/Pull amplifier is the junction of the two emitter resistors R1909 and R1910. The output of the final audio amplifier is capacitively coupled via C1904 to the speaker. Resistor R1917 provides feedback to the base of Q1901 to limit the gain and also prevent oscillations. Feedback is also provided to U1001-29 via R1912 and C1208.

Audio Troubleshooting (Mono)

First check for an audio signal at TP1202. If the signal is present, suspect Q1901, Q1902, or Q1903 and their associated components. If the audio signal is missing or distorted, confirm the presence of an audio signal at U1001-34. If the signal is present, suspect U1001 or the volume control voltage from U3300-37. If the audio signal is missing at pin 34 check for baseband video from U1001-47 and an output from the 4.5MHz BPF. If the input audio signal is present, suspect U1001, the components at pins 32/33, the components at pins 35/36, or CF1201. Be sure to check for +9 volts and ground at U1001 pins 37 and 40.

Listed below is a step-by-step procedure for checking the audio processing circuit.

1. Check Audio @ TP1202.
2. Check Video Output from U1001-47.
3. Check Audio @ U1001-34.
4. Check Volume Control Voltage @ TP1201.
5. Check Audio at TP1215 & TP1808.

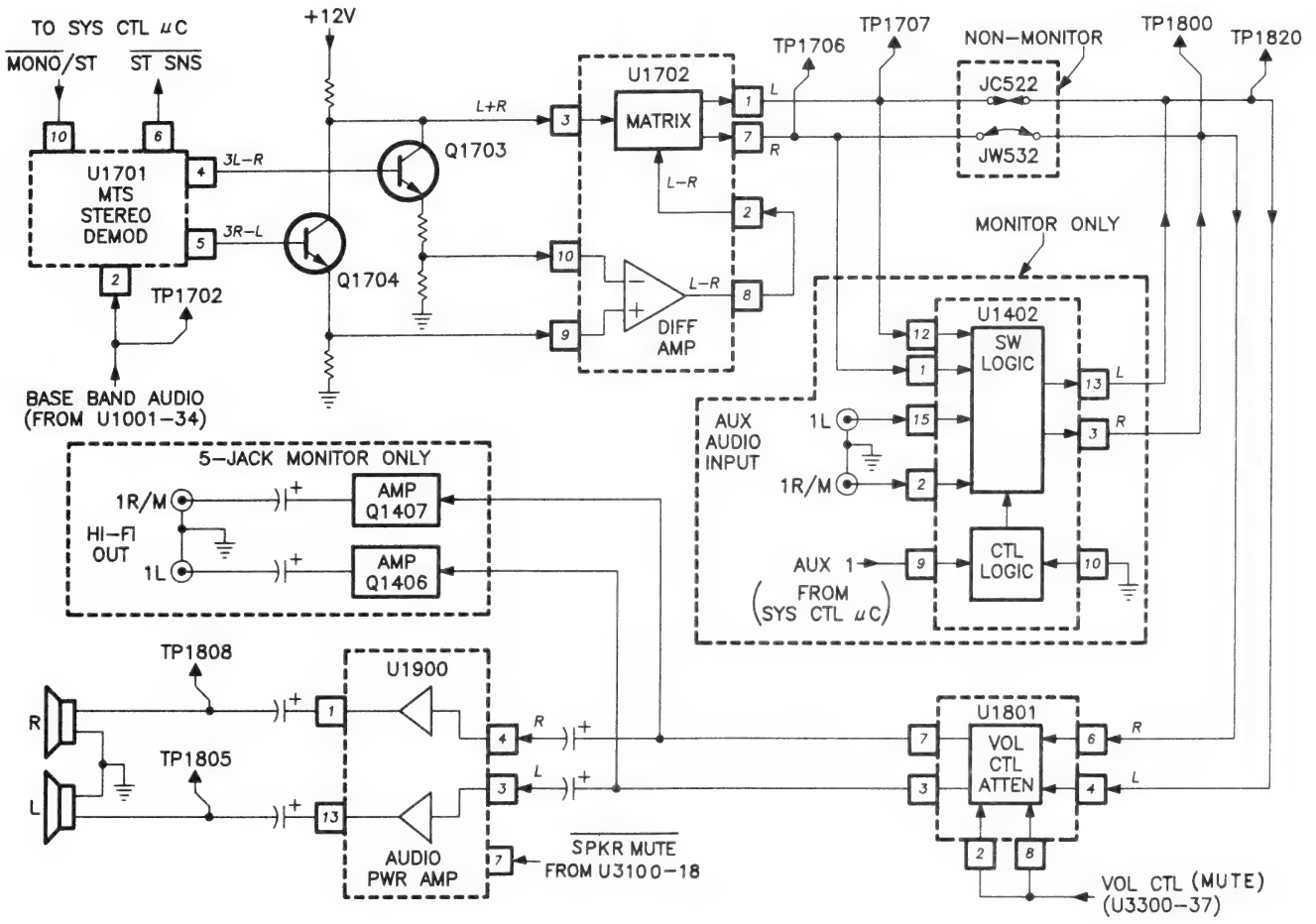


Audio Processing (Mono-CTC156/157)

Stereo Audio (CTC156/157)

The stereo system in the CTC156/157 is somewhat less complicated than the system in the CTC158/159. The CTC156/157 system doesn't have the Second Audio Program (SAP) function or tone control (Bass/Treble/Balance) options. However, the CTC156/157 does provide a single Aux Audio Input and a Hi-Fi output in the monitor models.

Baseband audio is input to the Stereo Demodulator (U1701) at pin 2. The baseband audio signal is developed by U1001 and is output from pin 34. The demodulator has a $\overline{\text{ST SNS}}$ output that is applied to the System Control μC. This signal informs the μC when a stereo signal is received. The $\overline{\text{MONO}}$/ST control signal from the system control μC is input to pin 10 of U1701.



Audio Processing (Stereo CTC156/157)

The audio signal that is output from U1701 is the 3L-R at pin 4 and 3R-L at pin 5. The audio output is applied directly to matrixing transistors Q1703 and Q1704. The output of Q1703 (collector) is the L + R and is applied to pin 3 of U1702. The emitter signals of both Q1703 and Q1704 are input to a differential amplifier within U1702. The output of the differential amplifier is the L-R signal. The L-R signal exits the IC at pin 8 and reenters at pin 2 where it is applied to the Matrix circuit along with the L + R signal. The output of the Matrix (pins 1 and 7) is the Left and Right audio signal.

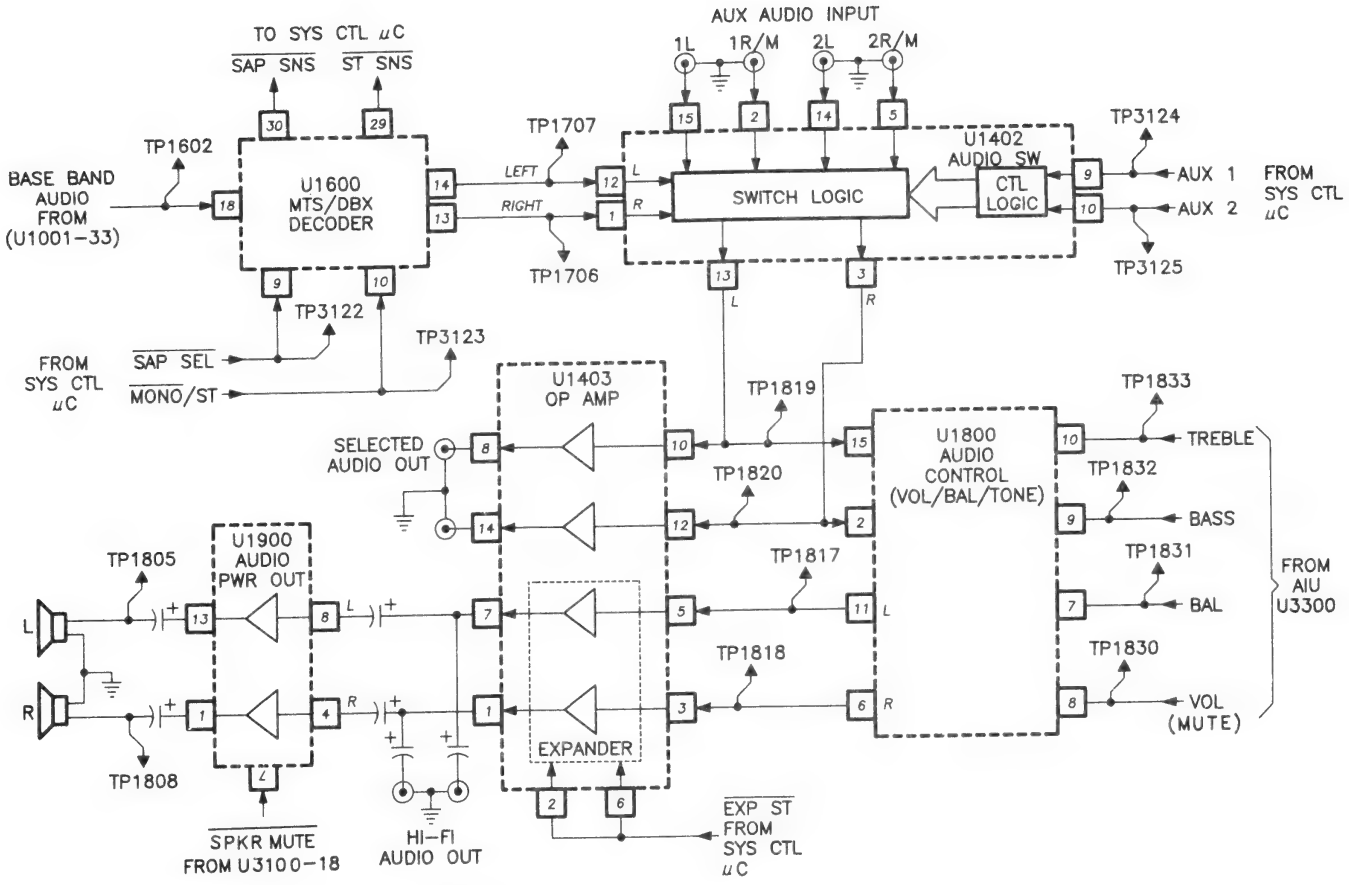
In monitor models (JC522 & JW532 removed) the audio signals are applied to the audio switching IC U1402. The output of the switching IC (pins 13 and 3 of U1402) are then applied to the volume control IC U1801 at pin 6 and 4. The DC volume control signal developed from the BRM output of the AIU is input to pins 2 and 8. The outputs of the volume control IC is capacitively coupled to the Audio Power Amplifier U1900. The $\overline{\text{SPKR MUTE}}$ control signal from U3100-18 acts as the internal speaker ON/OFF switch. The output of U1801 is also applied to amplifiers Q1406 and Q1407. Q1406 and Q1407 act as the output amplifiers for the Hi-Fi output jacks.

Troubleshooting

Troubleshooting the stereo system in the CTC156/157 is similar to troubleshooting the CTC158/159. Troubleshooting the CTC156/157 should be somewhat easier since there are fewer inputs and outputs. As with the more complex system found in the CTC158/159, the CTC156/157 monitor unit has more than one input and output and carefully identifying the malfunction is very important. For example, a symptom of "No Audio" is somewhat vague when dealing with a system that has multiple inputs and outputs. For this reason the troubleshooting process can be greatly shortened if the technician identifies the problem exactly, I.E. "NO TV Audio but Aux Audio In OK" or "TV & Aux Audio OK but No Hi-Fi Out", etc. For this reason the detailed operational check becomes very useful when troubleshooting any type of system that has multiple inputs and outputs.

Again, troubleshooting the audio system is a simple matter of signal tracing. The following procedure gives a step-by-step procedure for troubleshooting a "No TV Audio or Aux Audio" symptom.

1. Verify baseband audio output from U1001-34 (TP1702).
2. Check $\overline{\text{MONO}}$/ST & $\overline{\text{ST SNS}}$ signals at pins 6 & 10 of U1701.
3. Check for audio output at U1701-4/5.
4. Check for audio input at U1702-3/9/10.
5. Check audio at TP1706 & TP1707.
6. Verify audio at TP1800/TP1820.
7. Verify volume control signal at U1801-2/8.
8. Check for audio at U1801-3/7.
9. Check for audio at TP1805 & TP1808 and also at Hi-Fi output jacks.



Audio Processing (MTS Stereo/DBX–CTC158/159)

MTS Stereo/dbx Audio (CTC158/159)

The audio system in the CTC158/159 chassis consists of five (5) major IC's. These include U1600, the MTS/DBX Decoder, U1402-the audio input switching IC, U1800-the Volume/Balance/Tone control IC, U1403-the amplifier/expander IC and U1900-the Audio Power Out amplifier. The audio system in the CTC158/159 is a full-featured MTS stereo system with SAP (Second Audio Program) and DBX noise reduction system.

The baseband audio signal from U1001-33 is a applied to the MTS/DBX Decoder U1600 at pin 18. Two important signals output from the Decoder IC is the $\overline{\text{SAP SNS}}$ and the $\overline{\text{ST SNS}}$ signal. These signals inform the System Control μC when an MTS stereo signal is received and also when a second audio program is present. The $\overline{\text{SAP SEL}}$ and the $\overline{\text{MONO}}$/ST signal are output from the System Control μC and are applied to U1600 at pins 9 and 10. These two signals instruct the decoder IC to select the desired audio signal–Mono, Stereo or SAP. All decoding and processing (matrixing, etc.) of the audio signal is accomplished internally within U1600. The left and right audio outputs exit the IC at pins 13 and 14 and may be monitored at TP1706 and TP1707.

The left and right audio signals next enter the audio switching IC U1402 at pins 1 and 12. The audio signal from the MTS/DBX decoder along with the Aux 1 and Aux 2 audio inputs are also applied to the switching logic within U1402. The switching logic is responsible for routing the desired outputs to pins 3 and 13 of U1402. The Aux 1 and Aux 2 inputs at pins 9 and 10 (from System Control μC) determine which of the three (3) possible inputs to U1402 are selected. Refer to the following logic table for U1402 to determine the signal levels at TP3124 and TP3125.

U1402 Logic Table

Audio Input	Pin No. 10	9
Aux 1 L	0	1
Aux 1 R/M	0	1
Aux 2 L	1	0
Aux 2 R/M	1	0
TV Left	0	0
TV Right	0	0
SVHS L	1	1
SVHS R	1	1

The left and right audio signals are next applied to the Audio Control IC U1800 (pins 2 and 15) and the amplifier IC U1403 (pins 10 and 12). The Audio Control IC U1800 is responsible for providing the Volume, Balance and Tone customer controls. The Treble, Bass, Balance and Volume control signals input at pins 7 through 10 are DC control voltages signals developed by filtering the BRM outputs of the AIU U3300. The left and right signals at pins 2 and 15 are routed through U1800 and exit the IC and pins 6 and 11. The audio signals from U1402 are also applied to U1403 at pins 10 and 12 where they are buffered/amplified and output at pins 8 and 14. These outputs are referred to as the Selected Audio Output.

The left and right audio from U1800 are also routed through U1403. The signals are input at pins 3 and 5 and are processed by an Expander that is controlled by the $\overline{\text{EXP ST}}$ output of the System Control μC. The audio exits U1403 at pins 1 and 7 and are capacitively coupled to the Audio Power Amp and also to the Hi-Fi Audio Output jacks. The $\overline{\text{SPKR MUTE}}$ control signal from U3100-18 acts as the internal speaker ON/OFF switch. The difference between the Selected Audio Out and the Hi-Fi Audio Out is that the Hi-Fi signal has been processed by the Vol/Bal/Tone Control IC and the Expander circuit within U1403 while the Selected Audio Out signal bypasses these two processing circuits and is applied directly to the selected output jacks.

MTS Stereo/DBX Troubleshooting

Because of the number of possible inputs to this type of circuit it is essential that the technician define or identify the exact symptom when troubleshooting the CTC158/159 MTS Stereo/DBX system. This is best accomplished by a detailed operational check. For example, if troubleshooting a "No Stereo" symptom, does the Aux inputs function normally. If they do, the problem is more than likely associated with the Decoder or the CTV Processor U1001.

When troubleshooting a problem in a MTS Stereo system, many times it is easier to use an MTS Stereo generator than to rely on "Off the Air" signals which may or may not contain all the necessary MTS stereo and SAP signals.

After identifying the malfunction, it becomes a simple matter of signal tracing through the circuit to determine which component has failed. Always check for the $\overline{\text{SAP SNS}}$ and $\overline{\text{ST SNS}}$ outputs from U1600 if Stereo or SAP can't be selected. If these signals are not present the System Control μC doesn't even realize that the MTS stereo and SAP signals are present, therefore the μC can't generate the necessary $\overline{\text{SAP SEL}}$ or $\overline{\text{MONO}}$/ST signals.

If an audio switching problem is suspected (U1402) insure that the proper control codes are output from the system control μC (TP3124/TP3125).

The following is a step-by-step procedure for troubleshooting a "No Stereo/SAP/Aux Audio" symptom.

1. Check baseband Audio TP1602
2. Check for $\overline{\text{SAP SNS}}$/$\overline{\text{ST SNS}}$ (if applicable).
3. Check $\overline{\text{SAP SEL}}$ and $\overline{\text{MONO}}$/ST (if applicable).
4. Check Left/Right Audio (TP1706 & TP1707).
5. Check Aux 1/Aux 2 control signals (TP3124/TP3125).
6. Left/Right output present from U1402 (TP1819/TP1820).
7. Check Vol/Bal/Tone DC control Voltages at TP1830/31/32/33).
8. Verify audio at TP1817/TP1818.
9. Check audio out of Power Amp TP1805/TP1808.

APPENDIX A

CTC156/57/58/59 TUNING TABLE

FREQUENCY (MHz) AND BANDSWITCH STATE CHART

This tuning table is valid for cable-capable TCHQ and TCHR/TCCR tuners and air-only TAHQ tuners. However, the table must be interpreted differently for each model of tuner.

- Band 3 operation is not applicable to TAHQ tuners because these air-only tuners will not tune Band 3 cable channels.
- Channel assignments in bands 3 and 4 are different for TCHQ and TCHR/TCCR tuners.
- The TCHQ and TCHR/TCCR tuner Band 4 frequencies are different for cable-mode tuning and air-mode tuning (UHF). Therefore, there are two tables for Band 4. One for air tuning and one for cable tuning. Because the Band 4 cable-channel frequencies and the UHF-channel frequencies overlap, it is possible to tune Band 4 cable channels with the air-only TAHQ tuner; however, the channel number displayed will not be correct.

CATV CH	RCA CH	PIX FREQ	SOUND FREQ	LO FREQ	FLO/K	AIU BAND SW A	AIU BAND SW B	BAND SW TO TUNER BS1	BAND SW TO TUNER BS2	BV/	TUNER BAND
2	2	55.25	59.75	101.00	0.7891	0V	0V	−12V	−12V	12V	1
3	3	61.25	65.75	107.00	0.8359	0	0	−12	−12	12	1
4	4	67.25	71.75	113.00	0.8828	0	0	−12	−12	12	1
4A	1	73.25	77.75	119.00	0.9297	0	0	−12	−12	12	1
5	5	77.25	81.75	123.00	0.9609	0	0	−12	−12	12	1
6	6	83.25	87.75	129.00	1.0078	0	0	−12	−12	12	1
A−2	98	109.25	113.75	155.00	1.2109	0	0	12	−12	12	2
A−1	99	115.25	119.75	161.00	1.2578	5	0	12	−12	12	2
A	14	121.25	125.75	167.00	1.3047	5	0	12	−12	12	2
B	15	127.25	131.75	173.00	1.3516	5	0	12	−12	12	2
C	16	133.25	137.75	179.00	1.3984	5	0	12	−12	12	2
D	17	139.25	143.75	185.00	1.4453	5	0	12	−12	12	2
E	18	145.25	149.75	191.00	1.4922	5	0	12	−12	12	2
F	19	151.25	155.75	197.00	1.5391	5	0	12	−12	12	2
G	20	157.25	161.75	203.00	1.5859	5	0	12	−12	12	2
H	21	163.25	167.75	209.00	1.6328	5	0	12	−12	12	2
I	22	169.25	173.75	215.00	1.6797	5	0	12	−12	12	2
7	7	175.25	179.75	221.00	1.7266	5	0	12	−12	12	2
8	8	181.25	185.75	227.00	1.7734	5	0	12	−12	12	2
9	9	187.25	191.75	233.00	1.8203	5	0	12	−12	12	2
10	10	193.25	197.75	239.00	1.8672	5	0	12	−12	12	2
11	11	199.25	203.75	245.00	1.9141	5	0	12	−12	12	2
12	12	205.25	209.75	251.00	1.9609	5	0	12	−12	12	2
13	13	211.25	215.75	257.00	2.0078	5	0	12	−12	12	2

NOTE: TAHQ tuners will not tune Band 3 channels.

J	23	217.25	221.75	263.00	2.0547	0	5	12	12	12	3
K	24	223.25	227.75	269.00	2.1016	0	5	12	12	12	3
L	25	229.25	233.75	275.00	2.1484	0	5	12	12	12	3
M	26	235.25	239.75	281.00	2.1953	0	5	12	12	12	3
N	27	241.25	245.75	287.00	2.2422	0	5	12	12	12	3
O	28	247.25	251.75	293.00	2.2891	0	5	12	12	12	3
P	29	253.25	257.75	299.00	2.3359	0	5	12	12	12	3
Q	30	259.25	263.75	305.00	2.3828	0	5	12	12	12	3
R	31	265.25	269.75	311.00	2.4297	0	5	12	12	12	3
S	32	271.25	275.75	317.00	2.4766	0	5	12	12	12	3
T	33	277.25	281.75	323.00	2.5234	0	5	12	12	12	3
U	34	283.25	287.75	329.00	2.5703	0	5	12	12	12	3
V	35	289.25	293.75	335.00	2.6172	0	5	12	12	12	3
W	36	295.25	299.75	341.00	2.6641	0	5	12	12	12	3

APPENDIX A Continued

CATV CH	RCA CH	PIX FREQ	SOUND FREQ	LO FREQ	FLO/K	AIU BAND SW A	AIU BAND SW B	BAND SW TO TUNER BS1	BAND SW TO TUNER BS2	BAND SW TO TUNER BV/U	TUNER BAND
W+ 1	37	301.25	305.75	347.00	2.7109	0V	5V	12V	12V	12V	3
W+ 2	38	307.25	311.75	353.00	2.7578	0	5	12	12	12	3
W+ 3	39	313.25	317.75	359.00	2.8047	0	5	12	12	12	3
W+ 4	40	319.25	323.75	365.00	2.8516	0	5	12	12	12	3
W+ 5	41	325.25	329.75	371.00	2.8984	0	5	12	12	12	3
W+ 6	42	331.25	335.75	377.00	2.9453	0	5	12	12	12	3
W+ 7	43	337.25	341.75	383.00	2.9922	0	5	12	12	12	3
W+ 8	44	343.25	347.75	389.00	3.0391	0	5	12	12	12	3
W+ 9	45	349.25	353.75	395.00	3.0859	0	5	12	12	12	3
W+10	46	355.25	359.75	401.00	3.1328	0	5	12	12	12	3
W+11	47	361.25	365.75	407.00	3.1797	0	5	12	12	12	3
W+12	48	367.25	371.75	413.00	3.2266	0	5	12	12	12	3
W+13	49	373.25	377.75	419.00	3.2734	0	5	12	12	12	3
W+14	50	379.25	383.75	425.00	3.3203	0	5	12	12	12	3
W+15	51	385.25	389.75	431.00	3.3672	0	5	12	12	12	3
W+16	52	391.25	395.75	437.00	3.4141	0	5	12	12	12	3
W+17	53	397.25	401.75	443.00	3.4609	0	5	12	12	12	3
W+18	54	403.25	407.75	449.00	3.5078	0	5	12	12	12	3
W+19	55	409.25	413.75	455.00	3.5547	0	5	12	12	12	3
NOTE: "Cable" Band 4 for TCHR/TCCR tuners starts here. TCHR/TCCR tuner values are shown in parenthesis ( ).											
W+20	56	415.25	419.75	461.00	3.6016	0(5)	5(5)	12(12)	12(-12)	12(0)	3(4)
W+21	57	421.25	425.75	467.00	3.6484	0(5)	5(5)	12(12)	12(-12)	12(0)	3(4)
W+22	58	427.25	431.75	473.00	3.6953	0(5)	5(5)	12(12)	12(-12)	12(0)	3(4)
W+23	59	433.25	437.75	479.00	3.7422	0(5)	5(5)	12(12)	12(-12)	12(0)	3(4)
W+24	60	439.25	443.75	485.00	3.7891	0(5)	5(5)	12(12)	12(-12)	12(0)	3(4)
W+25	61	445.25	449.75	491.00	3.8359	0(5)	5(5)	12(12)	12(-12)	12(0)	3(4)
W+26	62	451.25	455.75	497.00	3.8828	0(5)	5(5)	12(12)	12(-12)	12(0)	3(4)
W+27	63	457.25	461.75	503.00	3.9297	0(5)	5(5)	12(12)	12(-12)	12(0)	3(4)
W+28	64	463.25	467.75	509.00	3.9766	0(5)	5(5)	12(12)	12(-12)	12(0)	3(4)
NOTE: "Cable" Band 4 for TCHQ tuners starts here. TCHR/TCCR tuner cable Band 4 continues.											
W+29	65	469.25	473.75	515.00	4.0234	5	5	12	−12	0	4
W+30	66	475.25	479.75	521.00	4.0703	5	5	12	−12	0	4
W+31	67	481.25	485.75	527.00	4.1172	5	5	12	−12	0	4
W+32	68	487.25	491.75	533.00	4.1641	5	5	12	−12	0	4
W+33	69	493.25	497.75	539.00	4.2109	5	5	12	−12	0	4
W+34	70	499.25	503.75	545.00	4.2578	5	5	12	−12	0	4
W+35	71	505.25	509.75	551.00	4.3047	5	5	12	−12	0	4
W+36	72	511.25	515.75	557.00	4.3516	5	5	12	−12	0	4
W+37	73	517.25	521.75	563.00	4.3984	5	5	12	−12	0	4
W+38	74	523.25	527.75	569.00	4.4453	5	5	12	−12	0	4
W+39	75	529.25	533.75	575.00	4.4922	5	5	12	−12	0	4
W+40	76	535.25	539.75	581.00	4.5391	5	5	12	−12	0	4
W+41	77	541.25	545.75	587.00	4.5859	5	5	12	−12	0	4
W+42	78	547.25	551.75	593.00	4.6328	5	5	12	−12	0	4
W+43	79	553.25	557.75	599.00	4.6797	5	5	12	−12	0	4
W+44	80	559.25	563.75	605.00	4.7266	5	5	12	−12	0	4
W+45	81	565.25	569.75	611.00	4.7734	5	5	12	−12	0	4
W+46	82	571.25	575.75	617.00	4.8203	5	5	12	−12	0	4
W+47	83	577.25	581.75	623.00	4.8672	5	5	12	−12	0	4
W+48	84	583.25	587.75	629.00	4.9141	5	5	12	−12	0	4
W+49	85	589.25	593.75	635.00	4.9609	5	5	12	−12	0	4
W+50	86	595.25	599.75	641.00	5.0078	5	5	12	−12	0	4
W+51	87	601.25	605.75	647.00	5.0547	5	5	12	−12	0	4
W+52	88	607.25	611.75	653.00	5.1016	5	5	12	−12	0	4
W+53	89	613.25	617.75	659.00	5.1484	5	5	12	−12	0	4

APPENDIX A Continued

UHF CH	RCA CH	PIX FREQ	SOUND FREQ	LO FREQ	FLO/K	AIU BAND SW A	AIU BAND SW B	BAND SW TO TUNER BS1	BAND SW TO TUNER BS2	BV/U	TUNER BAND
NOTE: "Air" (UHF) Band 4 for all CTC156/57/58/59 tuners starts here.											
14	14	471.25	475.75	517.00	4.0391	5V	5V	12V	−12V	0V	4
15	15	477.25	481.75	523.00	4.0859	5	5	12	−12	0	4
16	16	483.25	487.75	529.00	4.1328	5	5	12	−12	0	4
17	17	489.25	493.75	535.00	4.1797	5	5	12	−12	0	4
18	18	495.25	499.75	541.00	4.2266	5	5	12	−12	0	4
19	19	501.25	505.75	547.00	4.2734	5	5	12	−12	0	4
20	20	507.25	511.75	553.00	4.3203	5	5	12	−12	0	4
21	21	513.25	517.75	559.00	4.3672	5	5	12	−12	0	4
22	22	519.25	523.75	565.00	4.4141	5	5	12	−12	0	4
23	23	525.25	529.75	571.00	4.4609	5	5	12	−12	0	4
24	24	531.25	535.75	577.00	4.5078	5	5	12	−12	0	4
25	25	537.25	541.75	583.00	4.5547	5	5	12	−12	0	4
26	26	543.25	547.75	589.00	4.6016	5	5	12	−12	0	4
27	27	549.25	553.75	595.00	4.6484	5	5	12	−12	0	4
28	28	555.25	559.75	601.00	4.6953	5	5	12	−12	0	4
29	29	561.25	565.75	607.00	4.7422	5	5	12	−12	0	4
30	30	567.25	571.75	613.00	4.7891	5	5	12	−12	0	4
31	31	573.25	577.75	619.00	4.8359	5	5	12	−12	0	4
32	32	579.25	583.75	625.00	4.8828	5	5	12	−12	0	4
33	33	585.25	589.75	631.00	4.9297	5	5	12	−12	0	4
34	34	591.25	595.75	637.00	4.9766	5	5	12	−12	0	4
35	35	597.25	601.75	643.00	5.0234	5	5	12	−12	0	4
36	36	603.25	607.75	649.00	5.0703	5	5	12	−12	0	4
37	37	609.25	613.75	655.00	5.1172	5	5	12	−12	0	4
38	38	615.25	619.75	661.00	5.1641	5	5	12	−12	0	4
39	39	621.25	625.75	667.00	5.2109	5	5	12	−12	0	4
40	40	627.25	631.75	673.00	5.2578	5	5	12	−12	0	4
41	41	633.25	637.75	679.00	5.3047	5	5	12	−12	0	4
42	42	639.25	643.75	685.00	5.3516	5	5	12	−12	0	4
43	43	645.25	649.75	691.00	5.3984	5	5	12	−12	0	4
44	44	651.25	655.75	697.00	5.4453	5	5	12	−12	0	4
45	45	657.25	661.75	703.00	5.4922	5	5	12	−12	0	4
46	46	663.25	667.75	709.00	5.5391	5	5	12	−12	0	4
47	47	669.25	673.75	715.00	5.5859	5	5	12	−12	0.	4
48	48	675.25	679.75	721.00	5.6328	5	5	12	−12	0	4
49	49	681.25	685.75	727.00	5.6797	5	5	12	−12	0	4
50	50	687.25	691.75	733.00	5.7266	5	5	12	−12	0	4
51	51	693.25	697.75	739.00	5.7734	5	5	12	−12	0	4
52	52	699.25	703.75	745.00	5.8203	5	5	12	−12	0	4
53	53	705.25	709.75	751.00	5.8672	5	5	12	−12	0	4
54	54	711.25	715.75	757.00	5.9141	5	5	12	−12	0	4
55	55	717.25	721.75	763.00	5.9609	5	5	12	−12	0	4
56	56	723.25	727.75	769.00	6.0078	5	5	12	−12	0	4
57	57	729.25	733.75	775.00	6.0547	5	5	12	−12	0	4
58	58	735.25	739.75	781.00	6.1016	5	5	12	−12	0	4
59	59	741.25	745.75	787.00	6.1484	5	5	12	−12	0	4
60	60	747.25	751.75	793.00	6.1953	5	5	12	−12	0	4
61	61	753.25	757.75	799.00	6.2422	5	5	12	−12	0	4
62	62	759.25	763.75	805.00	6.2891	5	5	12	−12	0	4
63	63	765.25	769.75	811.00	6.3359	5	5	12	−12	0	4
64	64	771.25	775.75	817.00	6.3828	5	5	12	−12	0	4
65	65	777.25	781.75	823.00	6.4297	5	5	12	−12	0	4
66	66	783.25	787.75	829.00	6.4766	5	5	12	−12	0	4
67	67	789.25	793.75	835.00	6,5234	5	5	12	−12	0	4
68	68	795.25	799.75	841.00	6.5703	5	5	12	−12	0	4
69	69	801.25	805.75	847.00	6.6172	5	5	12	−12	0	4

APPENDIX B

CTC 156/157/158/159 SYSTEM CONTROL MICROCOMPUTER (U3100) PIN DESIGNATIONS

PIN NUMBER	PIN DESIGNATION	DESCRIPTION
1	$\overline{\text{RES}}$	Reset: When the set is initially plugged in or after an AC line dropout, the reset pin starts low (<0.8V) and will then charge up to 5V within 400 msec. During an AC line dropout, the STBY SENSE transistor Q3103 senses the 12VSTBY supply dropping below 9 volts. This causes Q3102 to clamp the reset line low and also turns off the +5VSW supply.
2	$\overline{\text{INT}}$	Interrupt request — pulled High
3	Vpp	Not used, this pin should be open.
4	SYNC KILL	Sync Kill: This active-open (high Z) output signal provides stable OSD by forcing the horizontal oscillator to free run during channel change and autoprogramming. The pin will float to about 2.5 volts.
5	PIP AUDIO SWAP	CTC156/157 — Not Used CTC158/159 — Controls the switching of audio when instrument is equipped with Pix-In-Pix feature.
6	$\overline{\text{VERT KILL}}$	Active low output signal is used to defeat vertical deflection and also control degaussing of the picture tube during the first 2.5 seconds after the set is turned on. Also active during service-line display.
7	IF DEFEAT	Active-high output signal is used to defeat the IF to prevent tuner video from interfering with the selected AUX video inputs.
8	CAV OUT	Not used.
9	$\overline{\text{EXP ST}}$	CTC156/157 — Not used CTC158/159 — This active-low output signal controls the expanded stereo feature.
10	AUX 1	This active-high output signal controls the switching of auxiliary video and audio inputs.
11	AUX 2	This active-high output signal controls the switching of auxiliary video and audio inputs.
12	$\overline{\text{AIU RES}}$	AIU Reset: This active-low output signal controls the resetting of the AIU. In normal operation, when the micro starts from a reset, the micro in turn forces a reset of the AIU before initializing it.
13	ENABLE	Enable: This signal, along with CLOCK and DATA, make up the 3-wire serial bus. Pin 13 goes low during the address portion of a message and high during the data portion. An 8 μsec low pulse indicates the end of the message. ENABLE is high when inactive.
14	$\overline{\text{ST SENSE}}$	Non Stereo — Not Used Stereo — This active-low input signal indicates that a stereo broadcast is being received.
15	$\overline{\text{SAP SENSE}}$	CTC156/157 — Not Used, pulled high. CTC158/159 — This active-low input signal indicates that a Secondary Audio Program (SAP) is being received.

APPENDIX B Continued

PIN NUMBER	PIN DESIGNATION	DESCRIPTION
16	CCM	Non Stereo — Not Used Stereo — (Channel Change Mute) This active-high output signal provides for muting of both internal and external audio during channel changes.
17	$\overline{\text{MONO/ST}}$	Non Stereo — Not Used. Stereo — This output signal controls the switching between stereo and monaural audio.
18	SPKR MUTE	Non Stereo — Not Used. Stereo — This active-high output signal controls the muting of the internal (TV) speakers.
19	$\overline{\text{SAP SEL}}$	CTC156/157 — Not Used, pulled high. CTC158/159 — This active-low output signal selects the Secondary Audio Program.
20	VSS	Microcomputer ground.
21-24	KD0-KD3	Keyboard Drive Lines: These active-low outputs provide the low voltages for the keyboard sense inputs. The drive outputs pulse while a key is pressed. The keyboard code is also read from these lines during a warm-start (see section on keyboard interface).
25-28	KS0-KS3	Keyboard Sense Lines: These active-low inputs are pulled high when no key is pressed. When a key is pressed, low pulses will appear on the corresponding KS input.
29-30	RDI-TDO	Data In-Data Out: These two pins are only used on commercial models, otherwise they are not used.
31-32	DATA IN/OUT	Data In/Out: These two pins make up the DATA signal of the 3-wire serial bus. DATA is high when inactive.
33	CLOCK	Clock: This signal is part of the 3-wire serial bus. It is used to synchronize data transfer. CLOCK is high when inactive.
34	(UNLABLED)	Master/Slave: This pin selects either master or slave operation of the micro. Pin 34 must be tied to +5VSW for normal operation (master mode). If the pull-up resistor (R3123) becomes open, unusual system control symptoms may result.
35	N.C.	Not used, this pin is left open.
36	$\overline{\text{XRP DET}}$	X-Ray Protection Detect: This input pin is used to monitor the +9V RUN supply. If a low is detected at pin 36, when the set should be on, the micro tries to restart the set at a cycle of 2 sec OFF then 0.25 sec ON.
37	N.C.	Not Used.
38	OSC2	4MHz Oscillator Out: Using a low capacitance probe (<3pF), a >4V p-p 4MHZ signal should be present when the oscillator is running.
39	OSC1	4MHz Oscillator In: Input pin for the xtal oscillator circuit.
40	VDD	Microcomputer 5V supply: 5V supply current is 10mA maximum, when the micro is running. When AC is removed, the pin drops to 1V in ~10 seconds.

APPENDIX C

CTC156/57/58/59 AIU (U3300) PIN DESIGNATIONS

PIN NUMBER	PIN DESIGNATION	DESCRIPTION
1	PHASE PULSES	Phase Pulses: This is the output of the phase comparator. When the frequency of the FLO/K is equal to an internal reference, the output will float at 2 volts. While tuning, 0 to 5V pulses at 3.9KHZ will be present.
2	PLL VSS	Phase-Locked Loop Ground.
3	PSC	Pulse Swallow Control: This output pin changes the divider ratio of the prescaler from ÷ 128 to ÷ 136 when active. It allows the tuner's local oscillator to be stepped in 31.25KHZ increments. With VHF signals on FCC nominal frequencies, no PSC pulses should be present. For UHF channels and offset cable channels, 1 to 15 pulses can be expected in a period of μ256 sec.
4	PLL VDD	Phase-Locked Loop + 5V Supply.
5	FLO/K	Frequency of the Local Oscillator ÷ K: K is either 128 or 136 (see pin 3 description). This is a .5Vp-p signal with a frequency of 0.7 to 7MHZ depending upon the channel. See the frequency and bandswitch state chart for specific channel frequencies.
6-7	BAND A-B	Bandswitch Logic Control: These two pins select one of the 4 tuner bands. See the frequency and bandswitch state chart for details (0 to 5V logic).
8	RFSW	Tuner RF Switch Control: Not used in the CTC156-9 (N.C.).
9	TEST	The test pin is grounded for use in the CTC156/57/58/59.
10	AFT OUT	AFT Output: Not used in the CTC156/57/58/59 (N.C.).
11	AFT IN	AFT Input: This pin will balance at 2.5 volts when the signal out of the I.F. is at 45.75MHZ. When tuning, this pin will change between 0 and 5V as the signal is below and above 45.75MHZ, respectively.
12	EIA	This input is not used and is tied to ground.
13	SYNC DET	Digital Sync Presence Detector: This is a video input to the AIU. It is used while tuning to detect when video is present on the signal being received (0 to 5V input). This video input is required for proper autoprogramming.
14	$\overline{\text{TV ON}}$	TV ON: In the CTC156/57/58/59, this open-drain, active-low output controls TV turn-on. When the set is off, this pin is open and the voltage at this pin is about 14 volts. When the set is on, this pin is pulled low (<0.3V).
15	$\overline{\text{PIX CLAMP}}$	Picture Contrast Clamp: In the CTC156/57/58/59, this open-drain output is active (low) during blanking. When active this pin pulls the contrast control low.
16	SHARP	Sharpness Control Output: This is a BRM (Binary Rate Multiplier) D/A output. The output consists of, 0 to 63, 4 μsec pulses during a 256 μsec period. This BRM signal is integrated (filtered) to provide a DC control voltage to the luma/chroma processing circuit.
17	COLOR	Color control output: Similar action as pin 16 but for color control.
18	TINT	Tint Control Output: Similar action as pin 16 but for tint control.

APPENDIX C Continued

PIN NUMBER	PIN DESIGNATION	DESCRIPTION
19	BRIGHT	Tint Control Output: Similar action as pin 16 but for brightness control.
20	CONTRAST	Contrast (PIX) Control Output: Similar action as pin 16 but for contrast control.
21	$\overline{\text{OSD BLK}}$	OSD Black (CTC156/157 Only): This active-low output signal drives OSD BLACK transistor Q2706 and blanks the luma output at U1001-13 during OSD display to provide the Black edge around characters.
22-23	N.C.	These pins are not used and are left open.
24	$\overline{\text{OSD}}$	On-Screen Display (CTC156/157): This active-low output signal drives Green Buffer transistor Q2903. Q2903 drives Green Drive transistor Q5004 on the CRT board. CTC158/159: This pin provides the tri-state On-Screen-Display signal to the 1-chip IC U1001. Low (O V) = OSD yellow color, High (5V) = Black, and Middle (1.6V) = video (No OSD).
25	VSS	Main AIU Ground.
26	OSD SYNC	This input signal is horizontal and vertical sync combined to synchronize the position of the OSD with video. The high level of this signal should be between 3V and 5V.
27-28	OSC OUT- OSC IN	7MHz oscillator output-input: These two pins connect to the OSD 7MHz LC oscillator. The oscillator only runs when OSD is active.
29	VDD	Main AIU 5V Supply.
30	CLK OUT	4MHz clock (oscillator) output: N.C. (4MHZ clock should be present).
31	CLK IN	4MHz clock (oscillator) input: This pin connects to the 4MHZ crystal oscillator, which is active when AC power is applied.
32	$\overline{\text{RESET}}$	AIU RESET Port: This active-low input forces the AIU into a reset condition. In the application, the micro (U3100) controls this pin. A reset pulse is generated each time the micro gets reset.
33	CLOCK	See Micro pin 33 for description (0 to 5V).
34	DATA	See Micro pins 31 and 32 for description. (0 to 5V).
35	ENABLE	See Micro pin 13 for description (0 to 5V).
36	IR IN	Infrared Remote Data Input: When receiving an IR signal from the transmitter, a >2Vp-p signal should be present at this pin.
37	VOLUME	Volume Control Output: This is a BRM D/A output consisting of, 0 to 63, 4 μsec pulses (0V to 5V) in a 256 μsec period. The pulses are then integrated (filtered) to provide a DC voltage to the audio preamp for volume control.
38	BALANCE	Balance control ouput: Not used in the CTC156/157 (N.C.).
39	TREBLE	Treble control output: Not used in the CTC156/157 (N.C.).
40	BASS	Base control output: Not used in the CTC156/157 (N.C.).

APPENDIX D

CTC156/157
U1001 IN-CIRCUIT RESISTANCE MEASUREMENTS

Resistance measured from IC pin to cold ground

CAUTION: All Measurements Taken With AC Power Removed!

Pin	Function	Resistance
1	X-Ray Protection Input	31.9K
2	Tint Control	24.9K
3	Color Control	43.0K
4	3.58MHz Oscillator	380.4K
5	Color Killer Detector Filter	352.5K
6	3.58MHz Oscillator	386.1K
7	Automatic Phase Control Filter	340.4K
8	Contrast Control	15.2K
9	R-Y Output	2.74K
10	G-Y Output	2.70K
11	B-Y Output	2.74K
12	Video/Chroma Ground	0
13	Luminance Output	46.9K
14	Black Level Clamp	234K
15	Brightness Control	13.9K
16	Video/Chroma/Deflection VCC	600Ω
17	Luminance Filter	27.1K
18	RF AGC Control	2.31K
19	Pix IF VCC	600Ω
20	IF Amp Input	26.7K
21	IF Amp Input	26.7K
22	IF AGC Switch	170K
23	IF AGC Filter	150K
24	PIX IF Ground	0
25	Ground	0
26	Ground	0
27	Ground	0
28	Mono Audio Out	380K
29	Audio Feedback	360K
30	Volume Control	3.03K
31	Mono Audio In	25.4K
32	Sound IF Tank	41.5K
33	Sound IF Tank	41.5K
34	Baseband Audio Out	2.81K
35	Sound IF Limiter	340K
36	Sound IF Input	340K
37	Sound IF VCC	615Ω
38	Ground	0
39	Ground	0
40	Sound IF Ground	0
41	Ground	0
42	AFT Output	8.09K
43	AFT Tank	14.3K
44	Video Detector	2.73K
45	Video Detector	2.73K
46	RF AGC Output	39.4K

APPENDIX D Continued

Pin	Function	Resistance
47	Video Output	1.00K
48	ACC Filter	315K
49	Chroma Input	8.6K
50	Deflection Ground	0
51	Sharpness Control	79.7K
52	Sharpness Input	38.5K
53	Luminance Input	362.7K
54	Not Connected	6.82K
55	Vertical Output	10.5K
56	Sync Separator Time Constant	352K
57	Sync Separator Input	353K
58	Horizontal VCC	302K
59	Horizontal AFC Input	38.4K
60	Horizontal AFC Input	47.0K
61	32H VCO Input	390K
62	32H VCO Input	410K
63	32H VCO Output	1.00K
64	Horizontal Drive Output	315K

APPENDIX E

CTC158/159
U1001 IN-CIRCUIT RESISTANCE MEASUREMENTS

Resistance measured from IC pin to cold ground

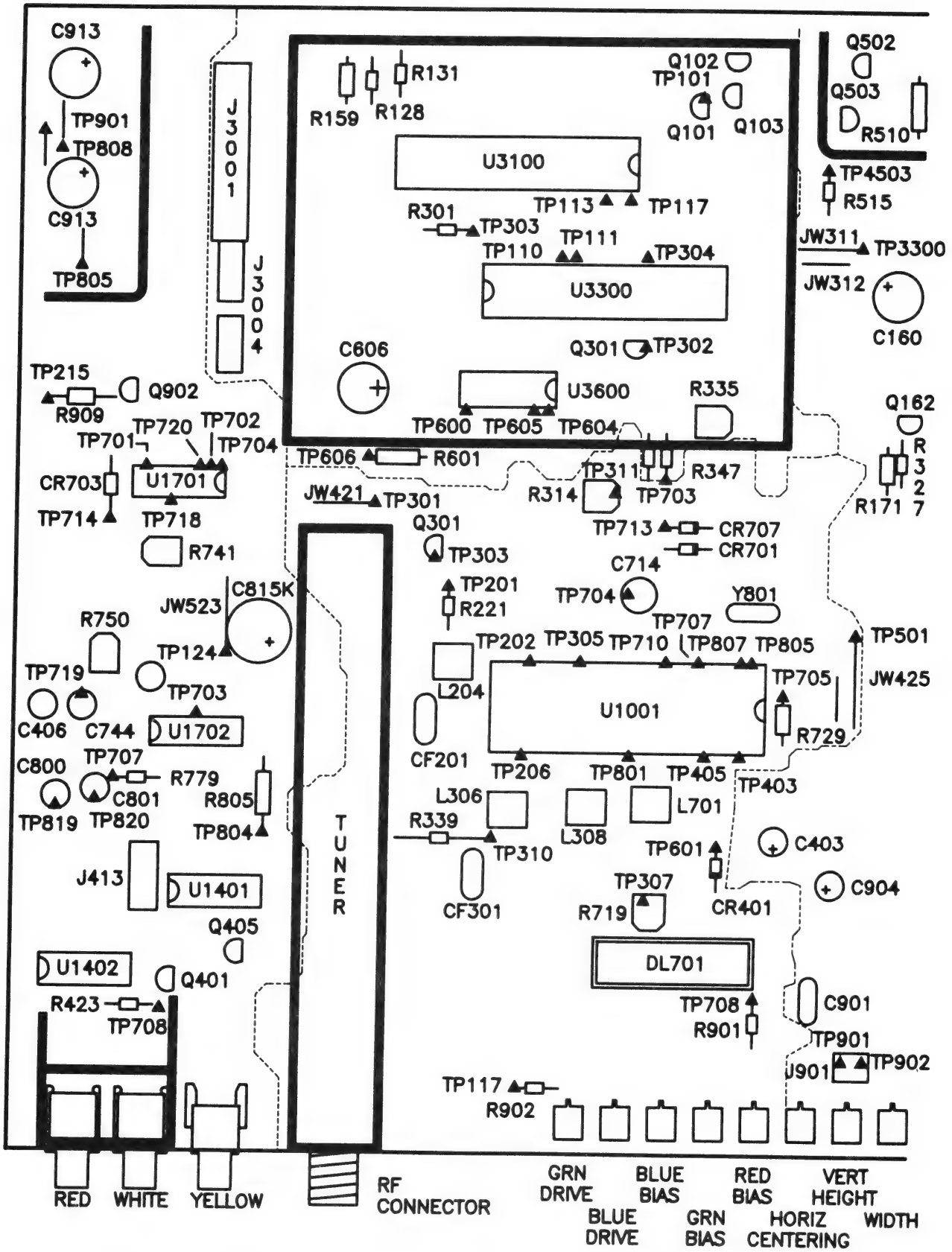
CAUTION: All Measurements Taken With AC Power Removed!

Pin	Function	Resistance
1	Tint	27.8K
2	Color	14.7K
3	3.58MHz OSC	350K
4	Killer Detector Filter	314K
5	3.58MHz OSC	352K
6	Automatic Phase Control Filter	306K
7	Auto Flesh Control	2.71K
8	Auto Flesh Control	38.6K
9	Auto Flesh Control	38.6K
10	Contrast	42.3K
11	R-Y Output	2.64K
12	G-Y Output	2.67K
13	B-Y Output	2.67K
14	Y-C Ground	0
15	On Screen Display Output	28.5K
16	Luminance DC Clamp	305K
17	Brightness Input	15.1K
18	Vertical Countdown VCC	1.22K
19	Luminance Filter	28.5K
20	Beam Limiter Input	38.9K
21	RF AGC	3.46K
22	Picture IF VCC	1.33K
23	IF Amp Input	28.7K
24	IF Amp Input	28.7K
25	IF AGC	156K
26	IF AGC Filter	138K
27	IF Ground	0
28	Sound IF Input	43.2K
29	Sound IF Input	43.2K
30	Sound IF AGC	22.0K
31	Sound IF Detector	43.6K
32	Sound IF Detector	43.6K
33	Baseband Audio Output	366K
34	Sound IF Limiter	329K
35	Sound IF Limiter	329K
36	Sound IF VCC	1.22K
37	Sound IF Detector	4.96K
38	Sound IF Detector	4.96K
39	Sound IF Ground	0
40	Sound IF Detector	750Ω
41	AFT Output	8.8K
42	AFT Detector	16.3K
43	Video Detector	3.58K
44	Video Detector	3.58K
45	RF AGC Output	36.6K
46	Video Output	1.79K

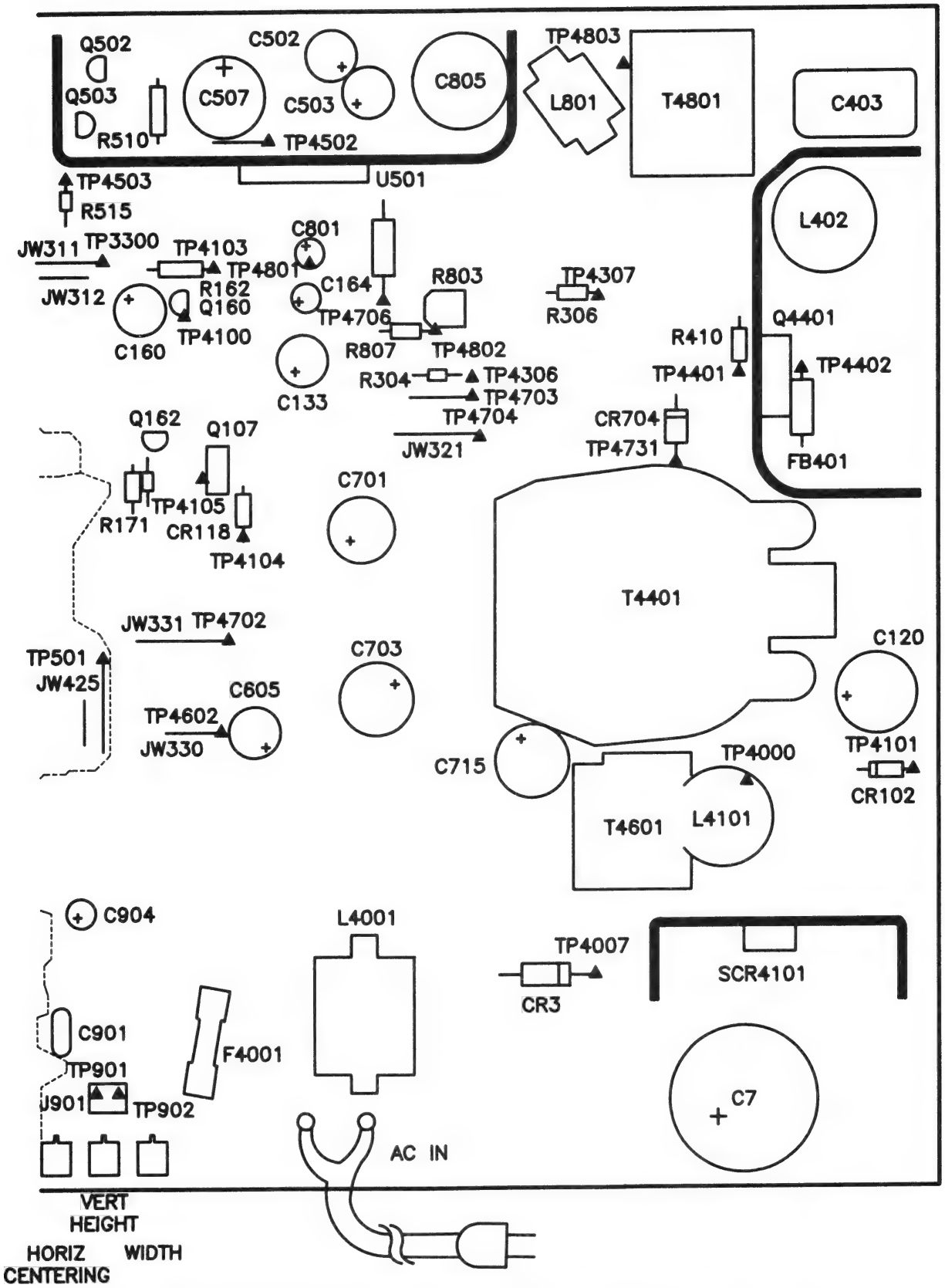
APPENDIX E Continued

Pin	Function	Resistance
47	OSD Control	325K
48	Automatic Color Control Filter	309K
49	Chroma Input	358K
50	Deflection Ground	0
51	Sharpness	80.4K
52	Sharpness Input	380K
53	Luminance Input	356K
54	Vertical Output	11.2K
55	Sync Separator	345K
56	Sync Separator	343K
57	Horizontal VCC	307K
58	Horizontal AFC Input	46.1K
59	Horizontal AFC Input	49.4K
60	32fH VCO	421K
61	32fH VCO	423K
62	32fH VCO	1K
63	Horizontal Drive Output	321K
64	X-Ray Protection Input	32.0K

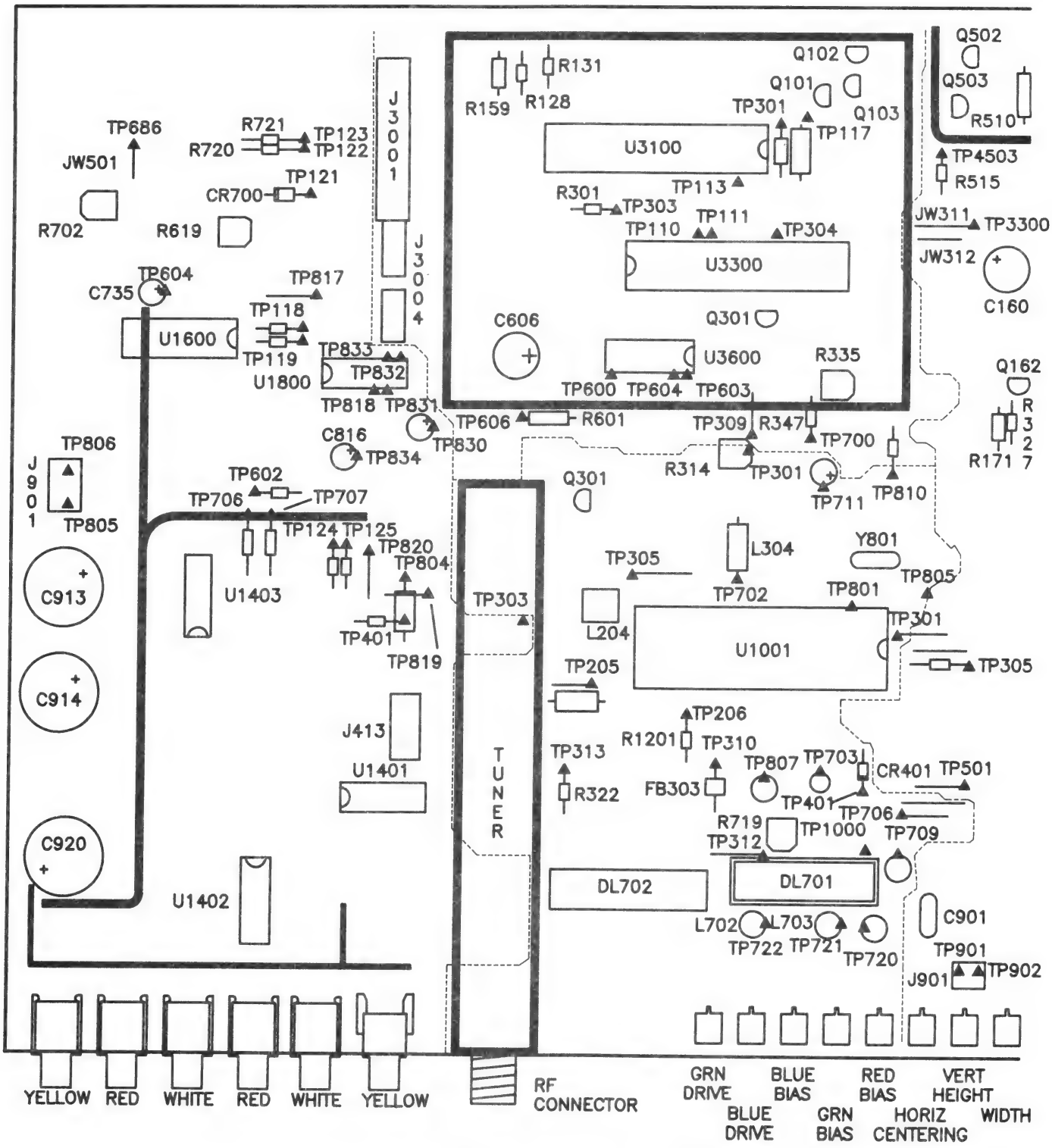
NOTES



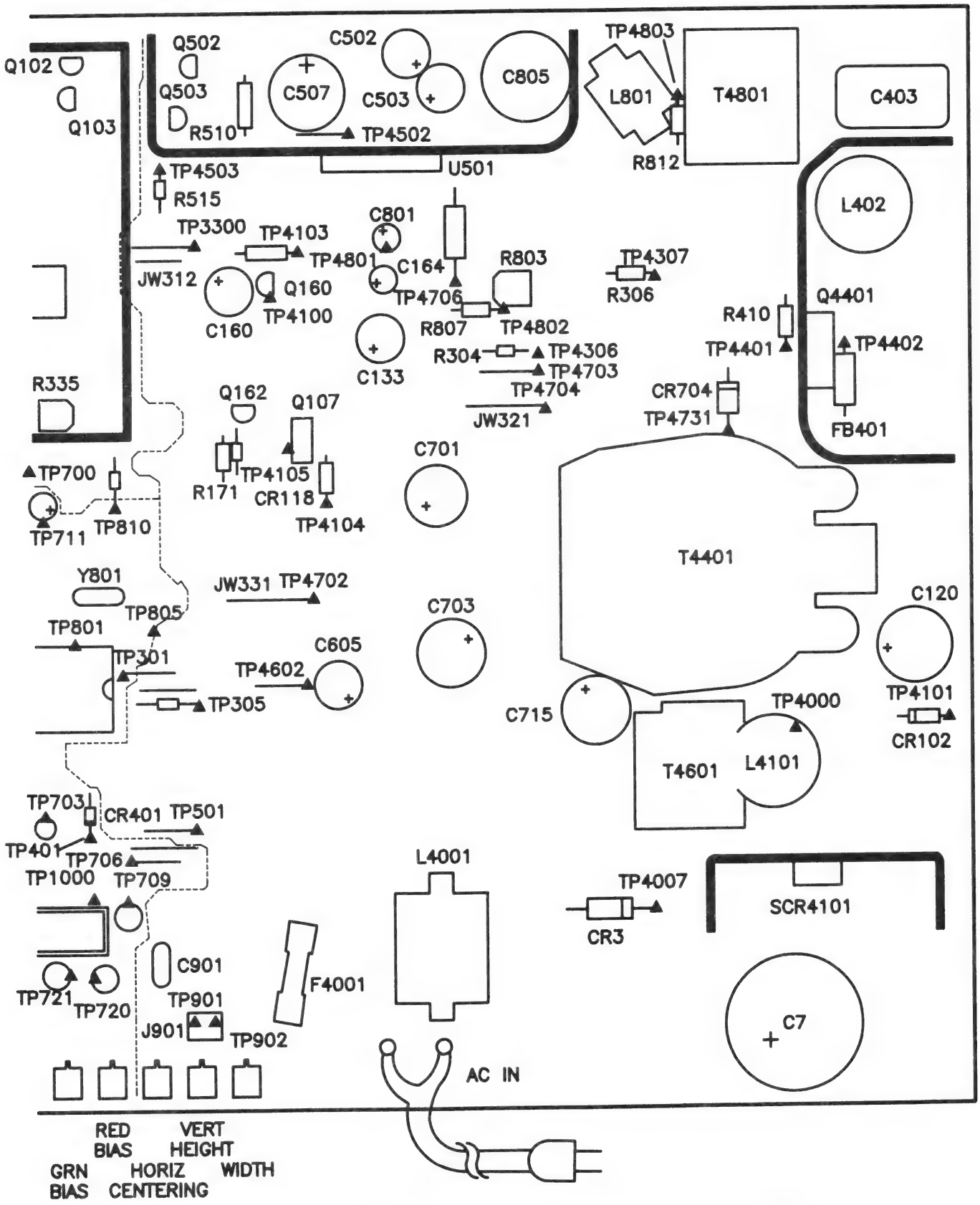
CTC156/157 Chassis Left Side Test Point Locations (Component Side View)



CTC156/157 Chassis Right Side Test Point Locations (Component Side View)



CTC158/159 Chassis Left Side Test Point Locations (Component Side View)



CTC158/159 Chassis Right Side Test Point Location (Component Side View)

EXERCISE 1

Purpose: The purpose of this exercise is to provide the technician with a review of basic troubleshooting concepts and the application of these concepts to malfunctions in the startup and B+ regulator circuits.

SECTIONALIZE

The basic concepts of troubleshooting require that some steps be taken before components are replaced. Begin by confirming that the set is properly connected and adjusted for normal operation. Perform a complete operational check. Verify the reported symptom and record any other symptoms that may be apparent. Next it is important to classify the symptom. These chassis can be divided into five major circuit areas:

1. Power Supply
2. System Control/Tuning
3. Signal Processing
4. Deflection
5. Audio

Normally, verifying the reported symptom enables the technician to sectionalize the malfunction to one of these major circuit areas before removing the back cover. For example, if the picture is normal but there is no audio, the problem is most likely to be in the audio section.

1. Which of the five major circuit areas could cause the observed symptom (dead set)? Check all that apply.

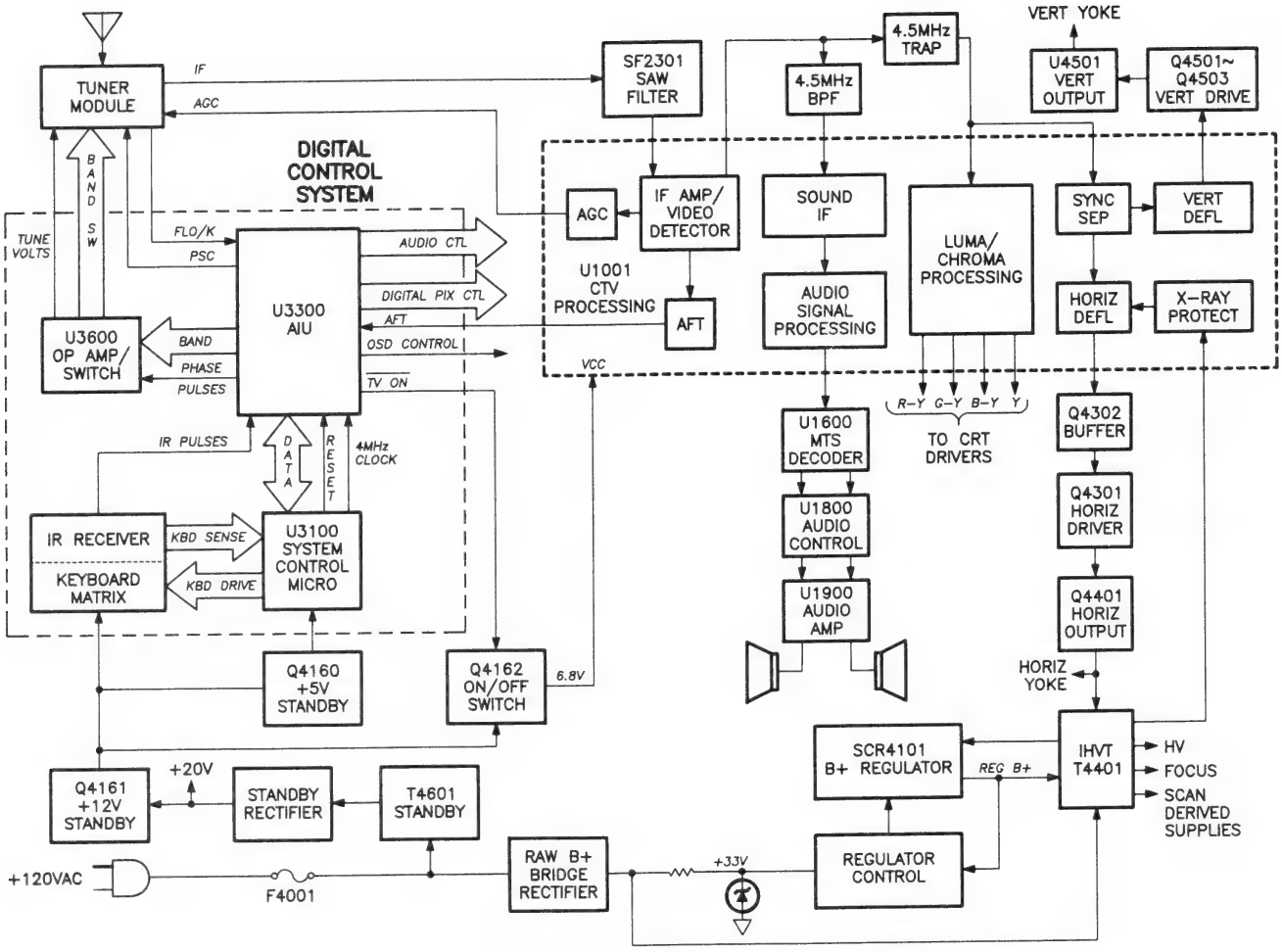
   ✓ Power Supply

   ✓ System Control/Tuning

   ____ Signal Processing

   ✓ Deflection

   ____ Audio



Simplified Block Diagram

2. What control signal from the system control circuit would quickly indicate that the system control section was operating normally and not the cause of the dead set?

____ IR Pulses into AIU

____ $\overline{\text{TV ON}}$ Output From AIU

____ Tuning Voltage to Tuner

____ OSD Control From AIU

____ Reset Pulse From U3100

3. Referring to the Startup Circuit simplified schematic, how could you substitute for the system control section and force the deflection circuit to operate?

   ____ Supply 5V DC at TP4108

   ____ Supply 5V DC at TP3301

   ____ Supply 5V DC to U3100 pin 1

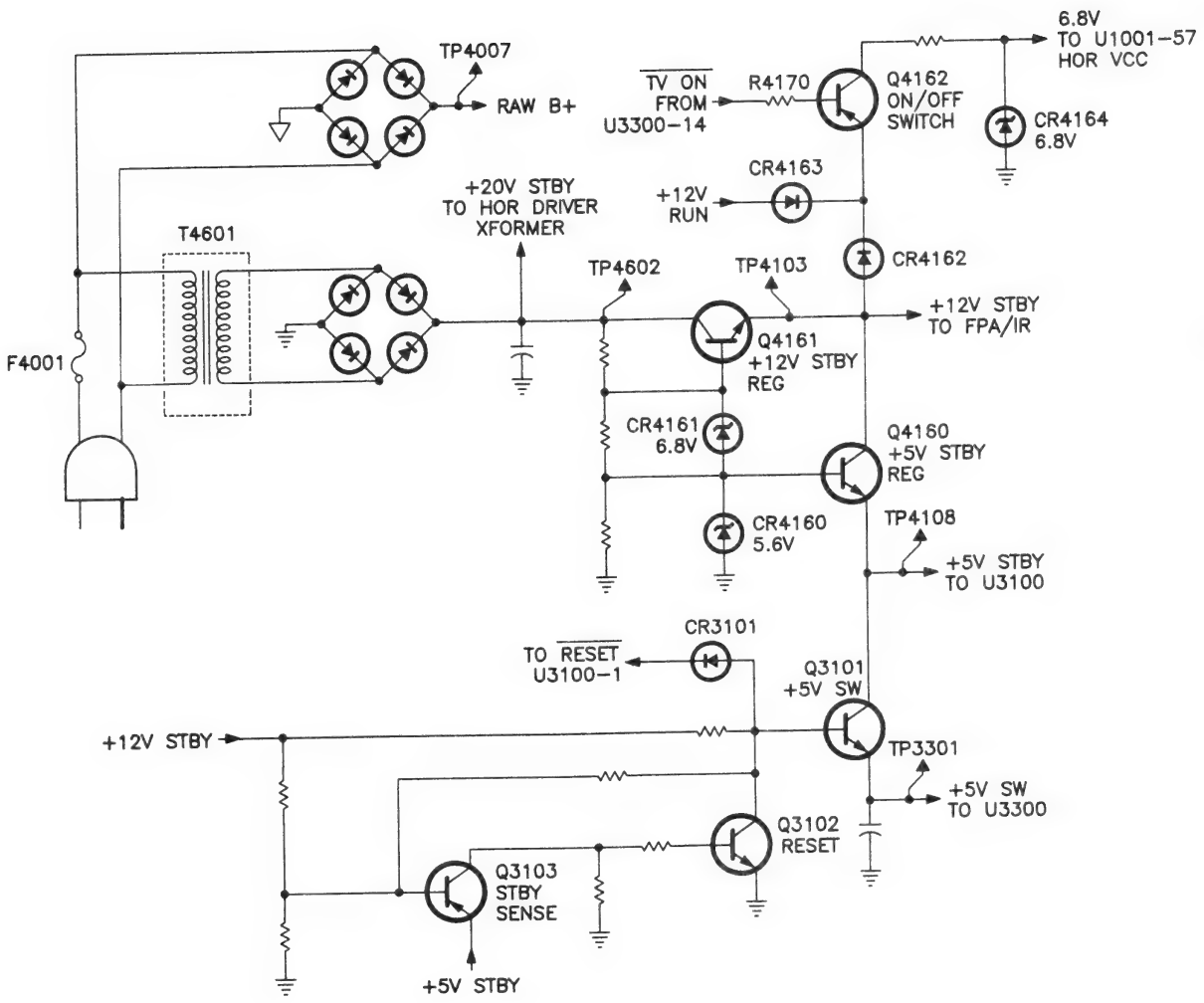
   ✓ Force Q4162 on by connecting a 1k Ohm resistor from the base to cold ground.

4. When the horizontal circuit is forced on, does the remainder of the chassis function normally (do the tuner and signal processing circuits operate)? Why or why not?

   NO
   Yes (Yes) Tuning system runs off standby power supply.

5. What is the purpose of the 5V Switched transistor Q3101?

   Purpose is to hold memory thru short Power outage



Startup Circuit

B+ Regulator Circuit Troubleshooting

In order to localize malfunctions to the regulator control circuit, it is necessary to bypass the regulator. To do this, it is necessary to use a variable isolation transformer. Connect a jumper between the raw B+ and the reg B+ supplies. Pins 2 and 12 of the high voltage transformer are a convenient place to connect the jumper. Monitor the DC voltage on the reg B+ supply and slowly increase the AC input voltage until the reg B+ supply is approximately 126 volts. If the set operates normally with the regulator bypassed, the malfunction must be in the regulator control circuit.

LOCALIZE

6. The regulator circuit operates even when the set is off. The regulated B+ supply is normally 126 volts with the set on. What is the voltage of the reg B+ line when the set is off?

   ____ 0 volts

   ____ 100 volts

   ____ 126 volts

   ____ Approximately the same as the raw B+

ISOLATE

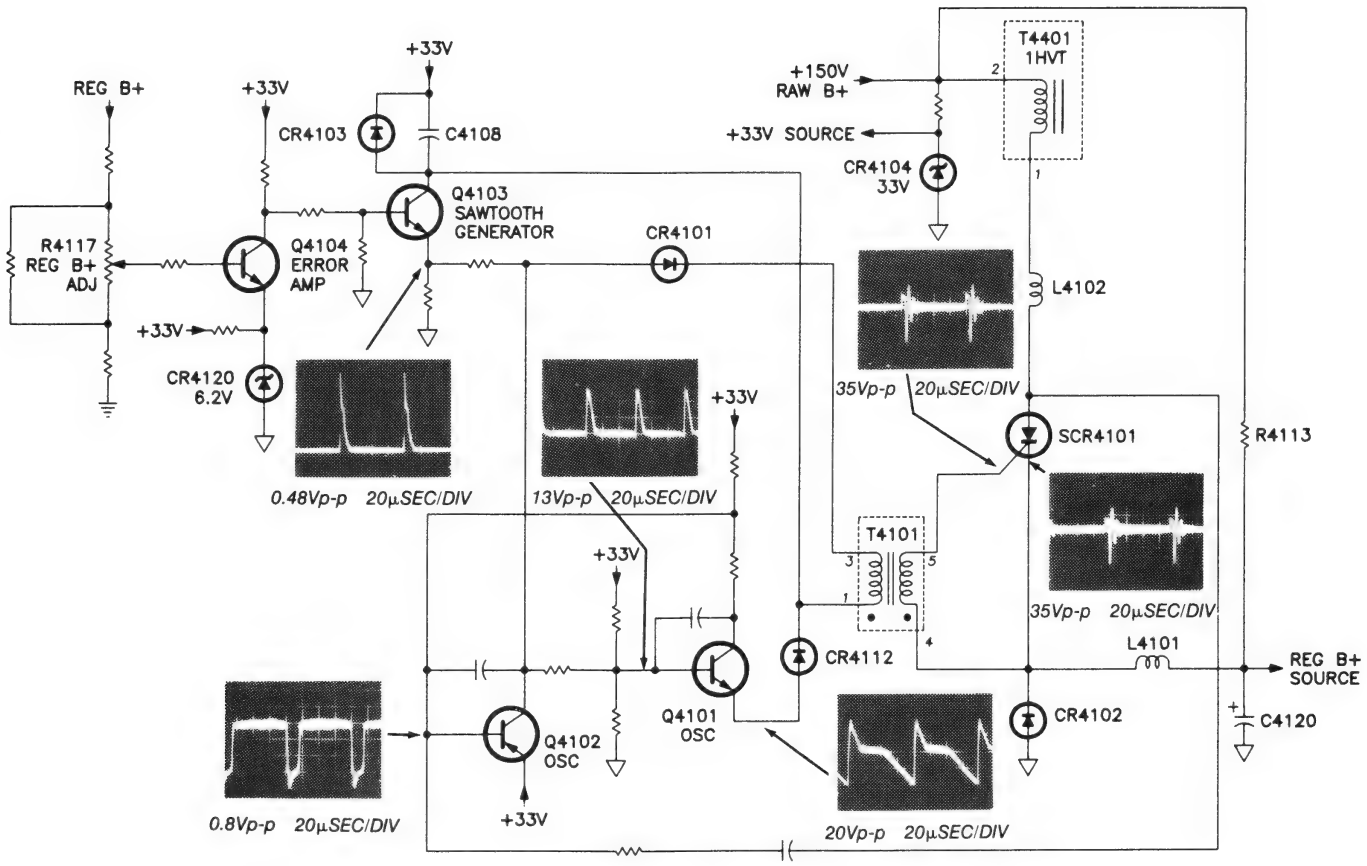
7. If the SCR turn-on pulses are missing at the gate of the SCR, how should the operation of the oscillator circuit be checked?

   ____ Check the 33V supply

   ____ Check for a sawtooth waveform at Q4103-C

   ____ Check the DC voltage at Q4103-C

   ____ All of the above



B+ Regulator Circuit

8. The voltage at the collector of Q4103 was found to be 11V DC with no sawtooth waveform. What components could cause this symptom? (Check all that apply)

   ____ Defective SCR

   ____ Shorted CR4103

   ____ Defective Q4103

   ____ Defective Q4104

End of Exercise 1

EXERCISE 2

Purpose: The purpose of this exercise is to provide the technician with troubleshooting hints for the vertical and horizontal deflection circuits of the CTC 156/57/58/59 color TV chassis.

Vertical Circuit Confirmation

1. To confirm proper operation of the vertical circuit, first confirm proper DC operation. What can be done to keep a problem in the AC portion of the vertical circuit from affecting the DC operation?

   ____ Run the vertical circuit using a DC power supply

   ✓ Force the vertical circuit off by obtaining the service line

   ____ Open the vertical yoke leads

   ____ Place a jumper across CR4504

2. These chassis do not have a rear panel service/normal switch. How is the service line obtained?

   by Turning set off & Plugging set in

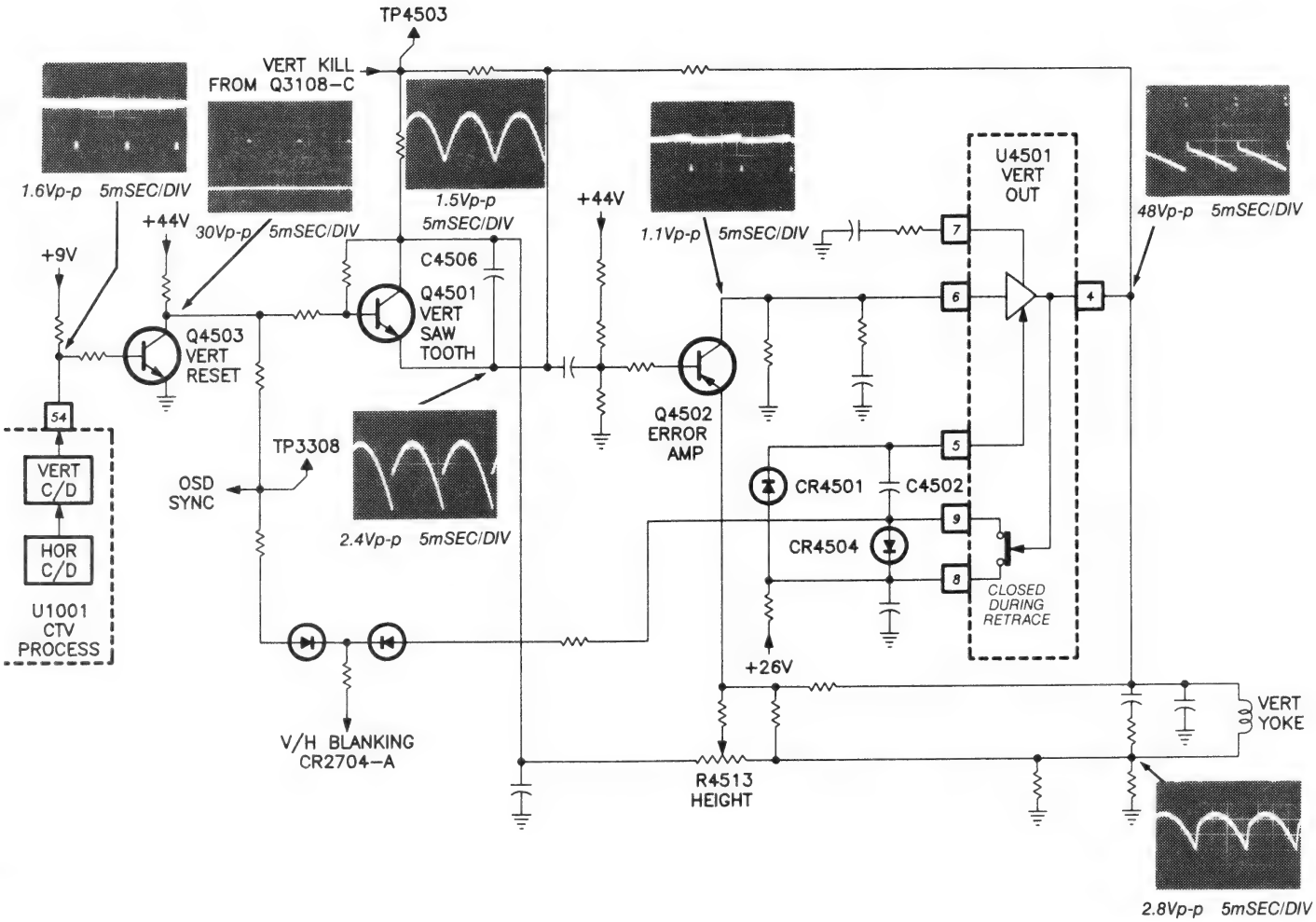
3. When the scan is collapsed, the DC output at pin 4 of U4501 is approximately half of the supply voltage, or about 13 volts. If this voltage is incorrect, what inputs must be checked before replacing U4501?

   ✓ DC voltage at U4501-6

   ✓ 26-volt supply

   ____ Vertical reset pulse at U1001-54

   ✓ 44-volt supply NOT Applicable



Vertical Deflection Circuit

4. What symptom would you expect if the vertical reset pulse was missing?

Retrace lines No vert sweep

5. What is the purpose of the vertical kill signal from the system control circuit (Q3108-C)?

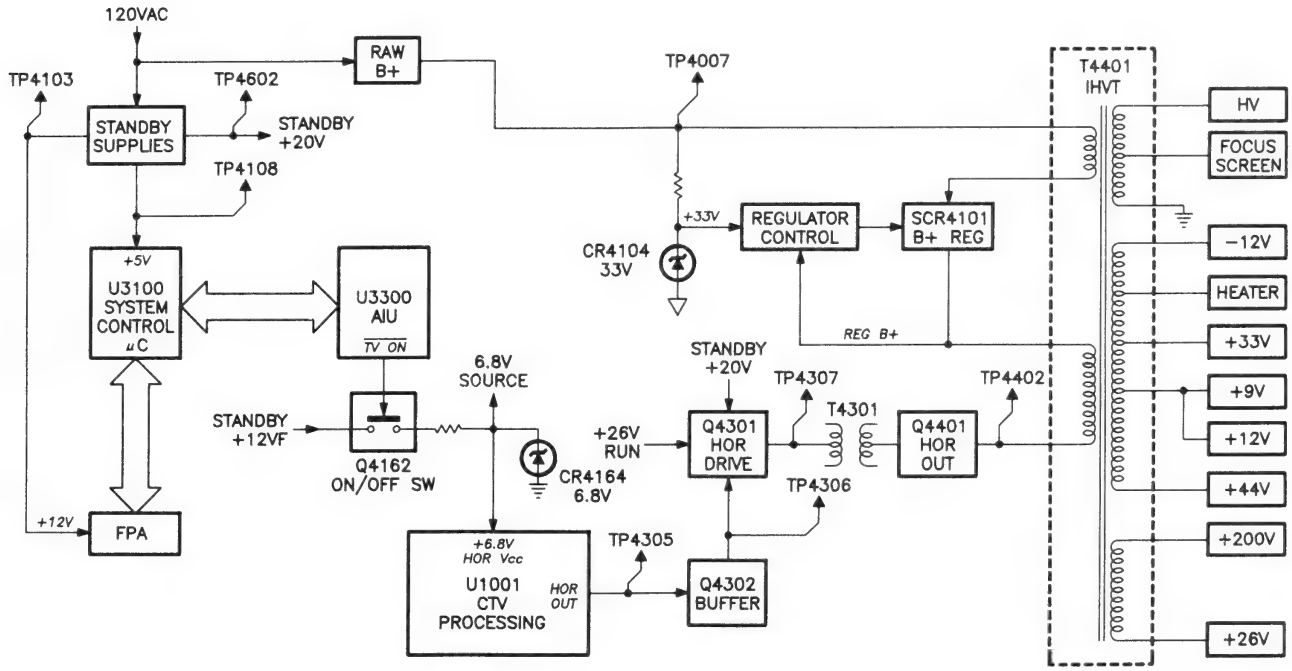
For set up & kill for flyback cycle

Horizontal Circuit Confirmation

Shutdown Troubleshooting

Any malfunction that prevents the production of the 9-volt run supply causes the system control microcomputer to shut the chassis down. In addition, faults in the system control circuits or the 9-volt run supply sensing network at the XRP DET port of the microcomputer can cause the same symptom. Some of the faults that can cause the cycling-shutdown symptom are:

- Activation of the X-ray protection circuit
- Loss of the 9 volt run supply
- 9-volt run supply sensing network problems
- Loss/low voltage of raw/reg B+
- Horizontal drive/output problems
- Standby supply problems
- Defective microcomputer



Startup/Deflection/Regulator Block Diagram

SECTIONALIZE

The operational check showed a cycling-shutdown symptom.

1. What major functional areas could not cause a cycling-shutdown symptom? (Check all that apply)

   ____ Power Supply
   ____ System Control
   ____ Signal Processing
   ____ Deflection
   ____ Audio

2. The raw B+ and standby supplies checked normal. The regulator circuit was bypassed and the on/off switch was forced on. What circuit areas can be eliminated as the cause of the problem if the horizontal circuit still shuts down? (Check all that apply)

   ____ Power Supply/B+ Regulator
   ____ System Control
   ____ Signal Processing
   ____ Deflection
   ____ Audio

LOCALIZE

Since the system control and regulator circuits have been eliminated as the cause of the symptom, the problem must be in the horizontal circuit.

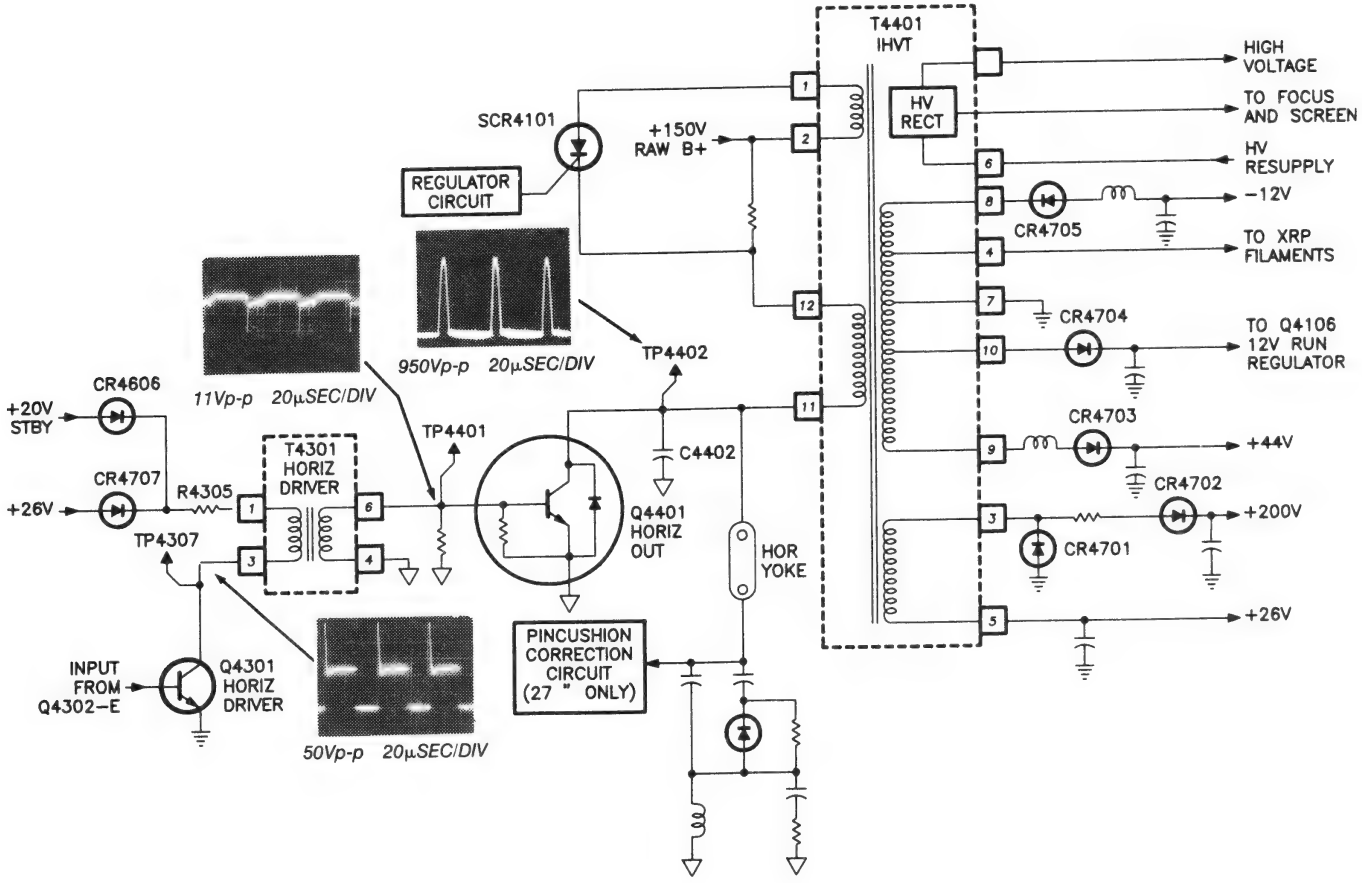
3. What circuit areas in the horizontal circuit could cause the cycling-shutdown symptom? (Check all that apply)

   ✓ High voltage transformer

   ____ Open horizontal yoke

   ____ Open retrace capacitor

   ✓ X-ray protection circuit



Horizontal Output Circuit

ISOLATE

When the horizontal circuit is forced to operate with the regulator circuit bypassed, the AC line input can be raised slowly and the waveform at the collector of the horizontal output transistor can be monitored.

4. If a normal waveform is not present at the collector of Q4401, what circuit areas would you suspect as the cause of the malfunction? (Check all that apply)

   ✓ Horizontal output transistor

   ✓ Primary circuit of the high voltage transformer

   ____ Raw B+ circuit

   ✓ Excessive load on the secondary of the IHVT

To confirm XRP shutdown as the cause, remove the reg B+ supply from the horizontal output transistor by unsoldering the collector of Q4401. Force operation of the horizontal circuit and check for the horizontal drive waveform at the base of Q4401 with the AC line input set to provide normal reg B+.

5. If the drive waveform remains stable with the full reg B+ applied, is XRP shutdown the cause of the malfunction?

   ____ Yes

   ____ No

End of Exercise 2

EXERCISE 3

Purpose: The purpose of this exercise is to provide the technician with a review of basic troubleshooting concepts and apply these concepts to malfunctions in the System Control/Tuning and Customer Interface Circuits.

SECTIONALIZE

1st Symptom: DEAD SET

The basic concept of troubleshooting requires that certain basic steps be taken before starting to replace components. Begin by confirming that the set is properly connected and adjusted for normal operation. Next, perform a complete operational check. Verify the reported symptom and record any other symptoms that may appear. Next it is important to sectionalize the problem. The chassis can be divided into five major circuit areas:

1. Power Supply
2. System Control/Tuning
3. Signal Processing
4. Deflection
5. Audio

Normally, verifying the reported symptom should enable the technician to sectionalize the malfunction to one of these major circuit areas before removing the back cover. I.E., If the picture is normal but there is no audio, the problem is most likely to be in the audio section.

1. Which of the five major circuit areas could possibly cause the observed symptom (dead set)? Check all that apply.

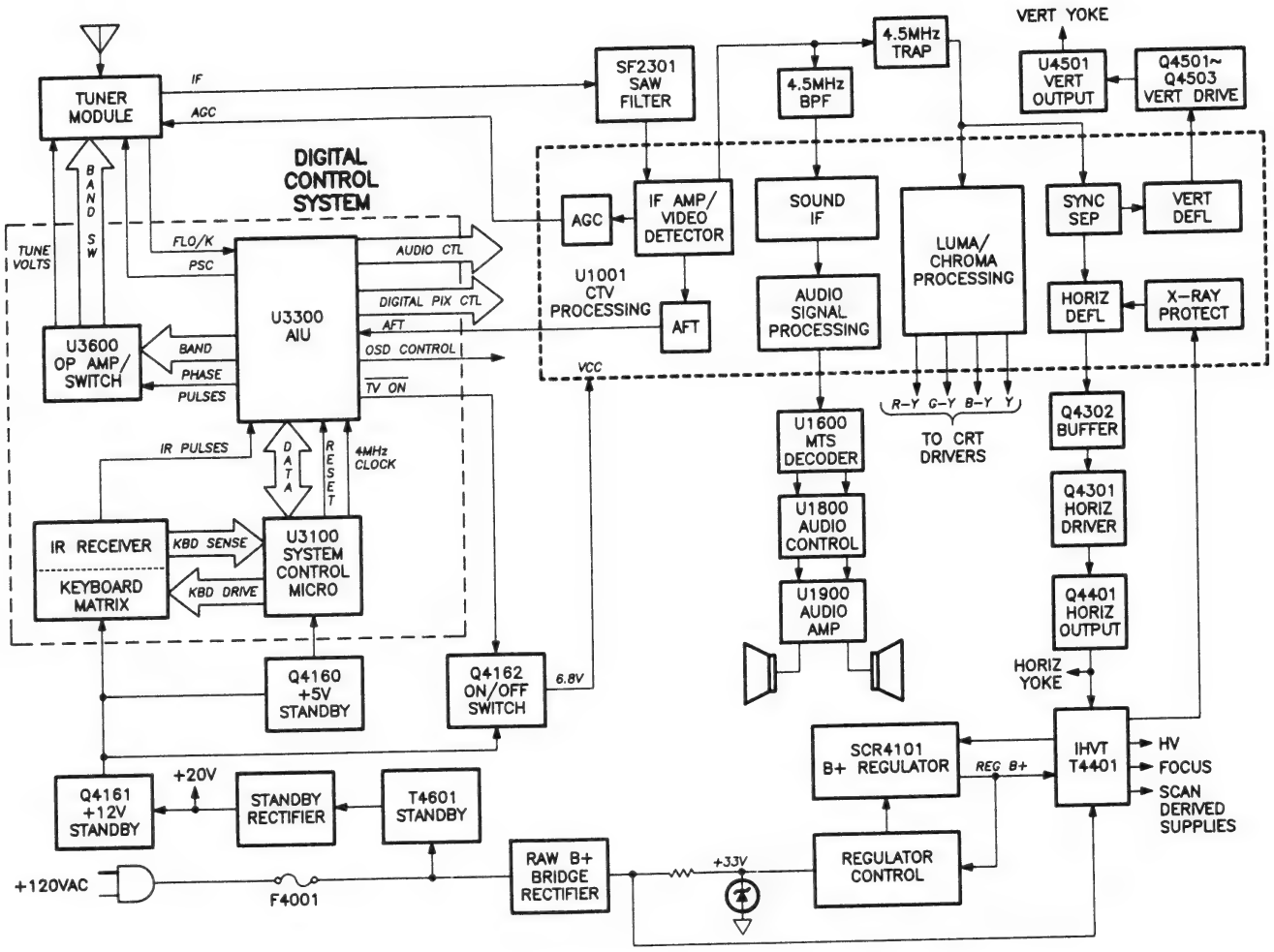
   ✓ Power Supply

   ✓ System Control/Tuning

   ____ Signal Processing

   ✓ Deflection

   ____ Audio



Simplified Block Diagram

2. What major signal(s) in the system control circuit could quickly indicate if the system control section was operating normally and was not causing the dead set? Check all that apply.

   ___ IR signal into AIU (TP3402)

   ___ $\overline{\text{TV ON}}$ Output From AIU

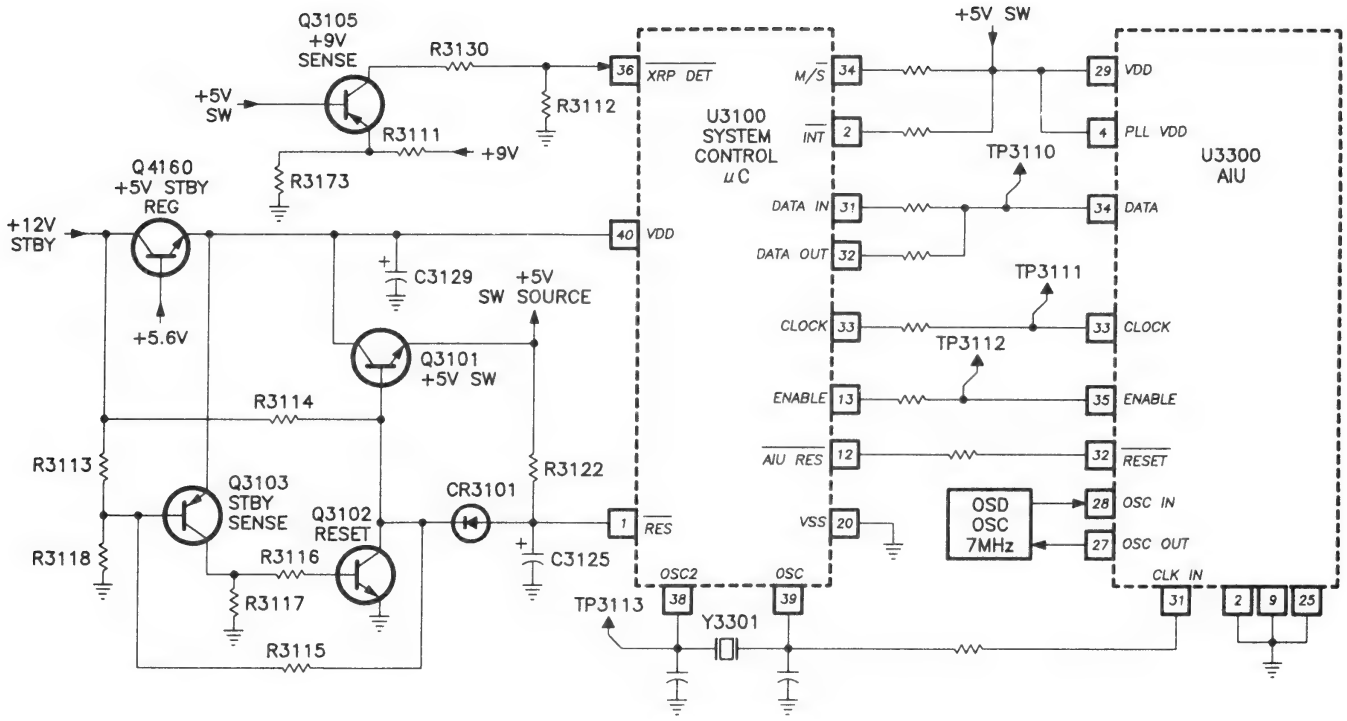
   ___ $\overline{\text{XRP DET}}$ to System Control uC

   ___ Reset Pulse From U3100 to U3300

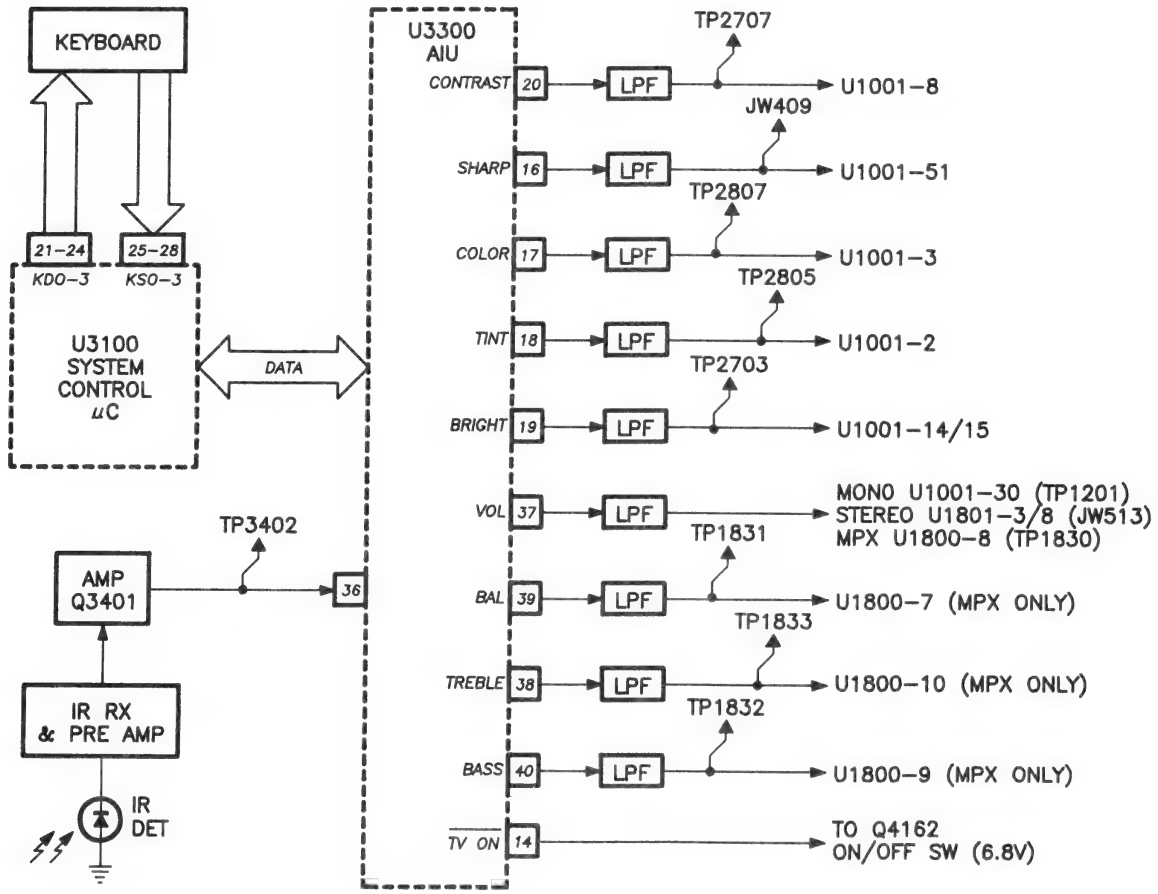
   ___ OSD Control Signal

   ___ IR Pulses

continue to next page



System Control/System Reset and Communications



Customer Control Interface

3. Referring to the System Control and Customer Control Interface block diagrams how could you bypass the system control section and force the power supply/deflection circuits to operate?

____ Supply 5V DC at U3100-40

____ Supply 5V DC at U3100-36

____ Supply 5V DC to U3300 pin 32

__✓__ Force Q4162 on by connecting a 1k Ohm resistor from the base to cold ground (see Startup Diagram in Ex. 1).

4. If the power supply/horizontal circuits operate when forced on, what area does this tell you the problem is located in.

System Control

LOCALIZE

5. With the Power Supply/Deflection circuits eliminated, could the IR Receiver/Amp and/or the Keyboard cause this problem?

Yes ✓ No ____

6. How would you eliminate the IR Receiver and Keyboard?

check for IR at pin 32 of U3300

7. What two (2) major components or stages do you feel the problem is localized down to?

System Control & AIC

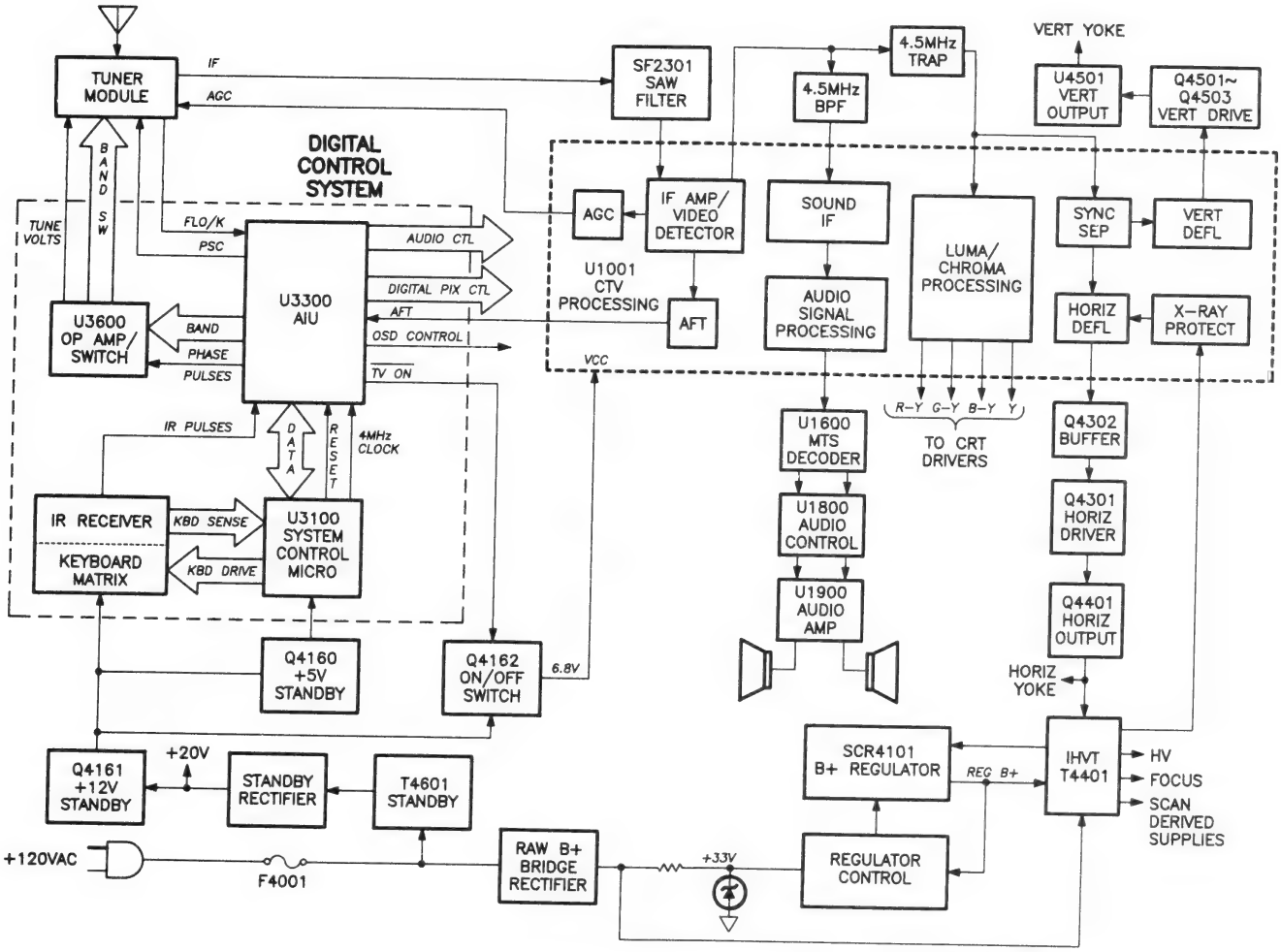
ISOLATE

8. List the major signals that you would check given this type of problem.

Proper voltage on XRP Det
VDD - 5V
4 MHz osc
M/C

EM?

Stop – Wait for Instructor



Simplified Block Diagram

Ex. #3 Continued

2nd Symptom: No Video or Audio
OSD OK
No Autoprogram

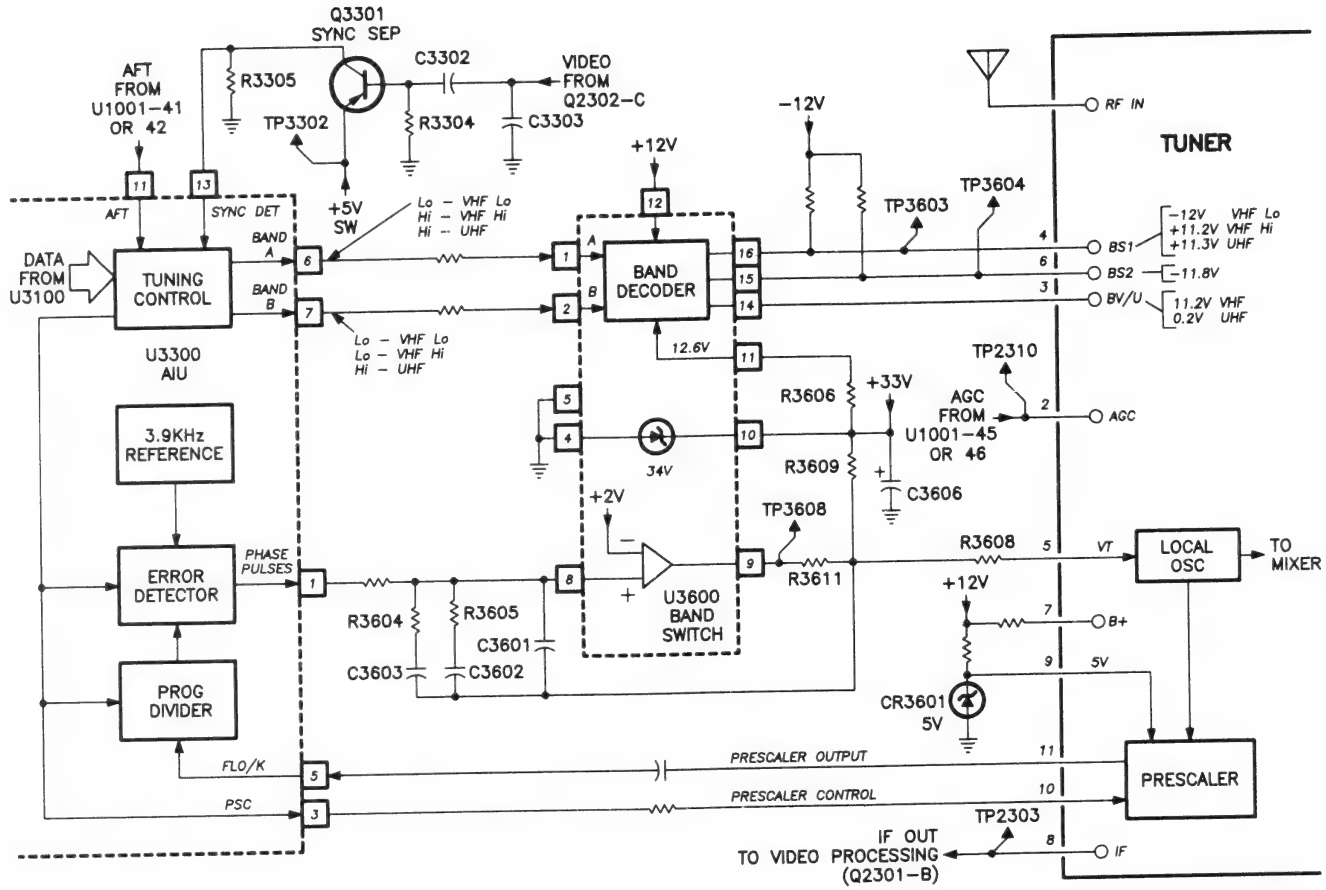
SECTIONALIZE

9. Which of the five major circuit areas might cause the observed symptoms? Check all that apply.

___ Power Supply
___ System Control/Tuning
___ Signal Processing
___ Deflection
___ Audio

10. What does the operational On-Screen-Display tell you about System Control μC operation?

It indicates chips OK



Tuning Control

LOCALIZE

11. What one major signal could you check to narrow the problem down to one area?

~~[illegible]~~ VT change

ISOLATE

12. List the major signals that you would check to isolate the problem to a stage and/or component.

End of Exercise 3

EXERCISE 4

Purpose: The purpose of this exercise is to provide the technician with a review of basic troubleshooting concepts and the application of these concepts to malfunctions in the Signal Processing and Audio Circuits.

SECTIONALIZE

Symptom: No TV or Aux Video
Auto Program OK
Audio OK
OSD OK

Efficient and effective troubleshooting requires that certain preliminary steps be taken. Begin by performing a complete operational check. Verify the reported symptom and record any other symptoms that may appear. Remember, it is also just as important to note what the instrument "Will" do as what it won't do. The next step after the operational check is to sectionalize the problem. The chassis can be divided into five major circuit areas or sections.

1. Which of the five major circuit areas could cause the observed symptom? Check all that apply.

   ____ Power Supply

   ____ System Control/Tuning

   ✓ Signal Processing

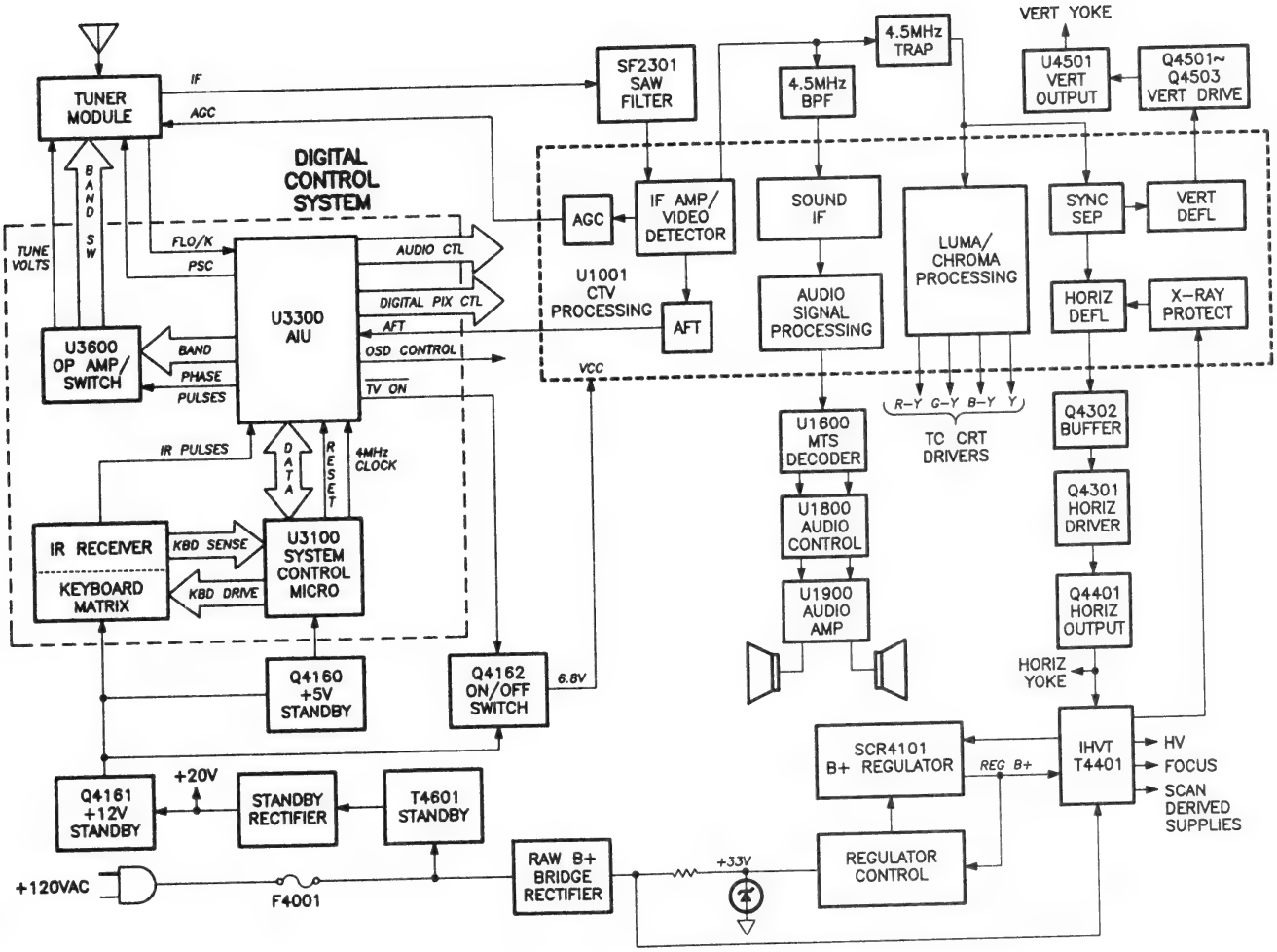
   ____ Deflection

   ____ Audio

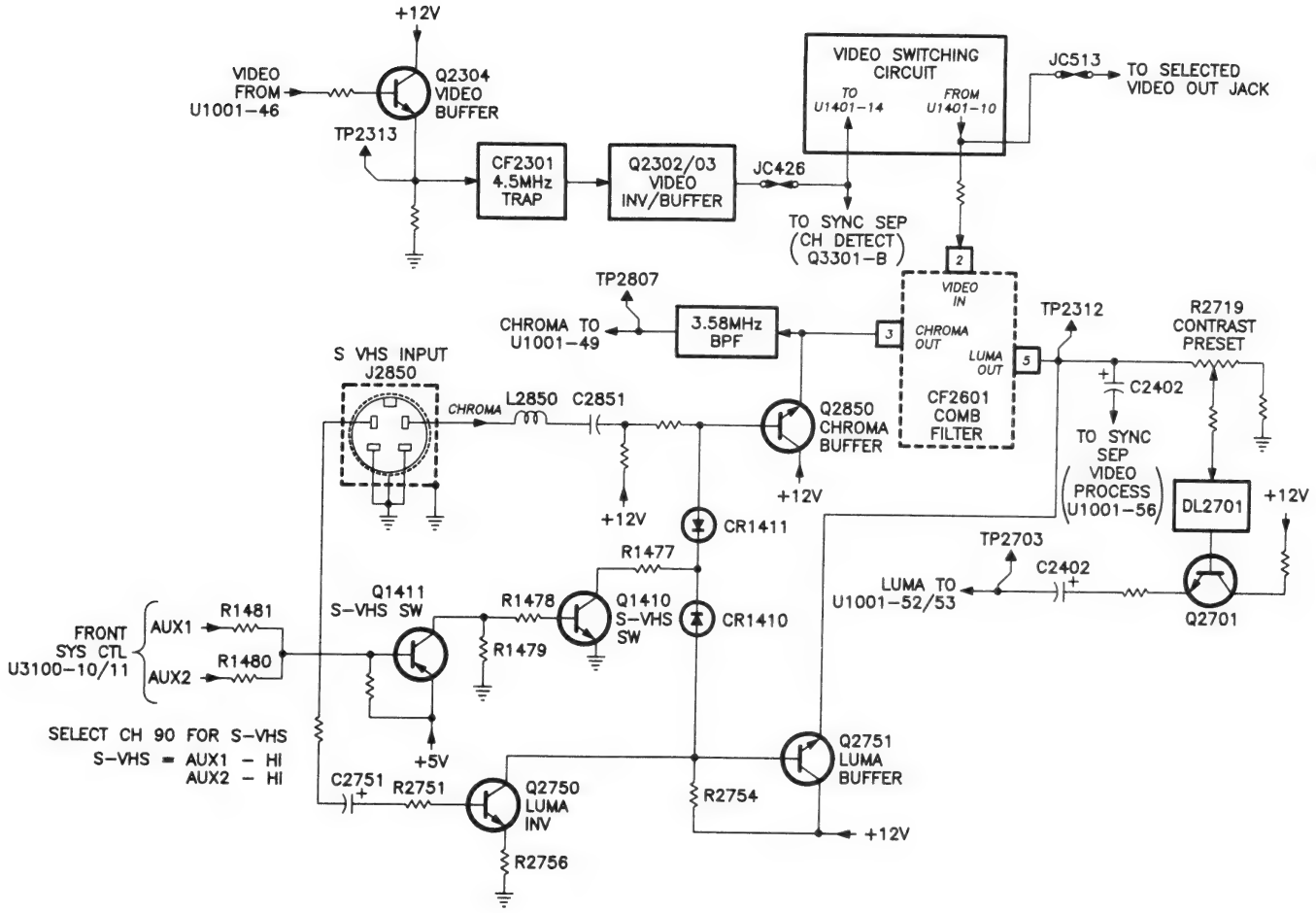
2. Do you feel the System Control/Tuning circuits could cause this problem?

   Yes ____ No ✓

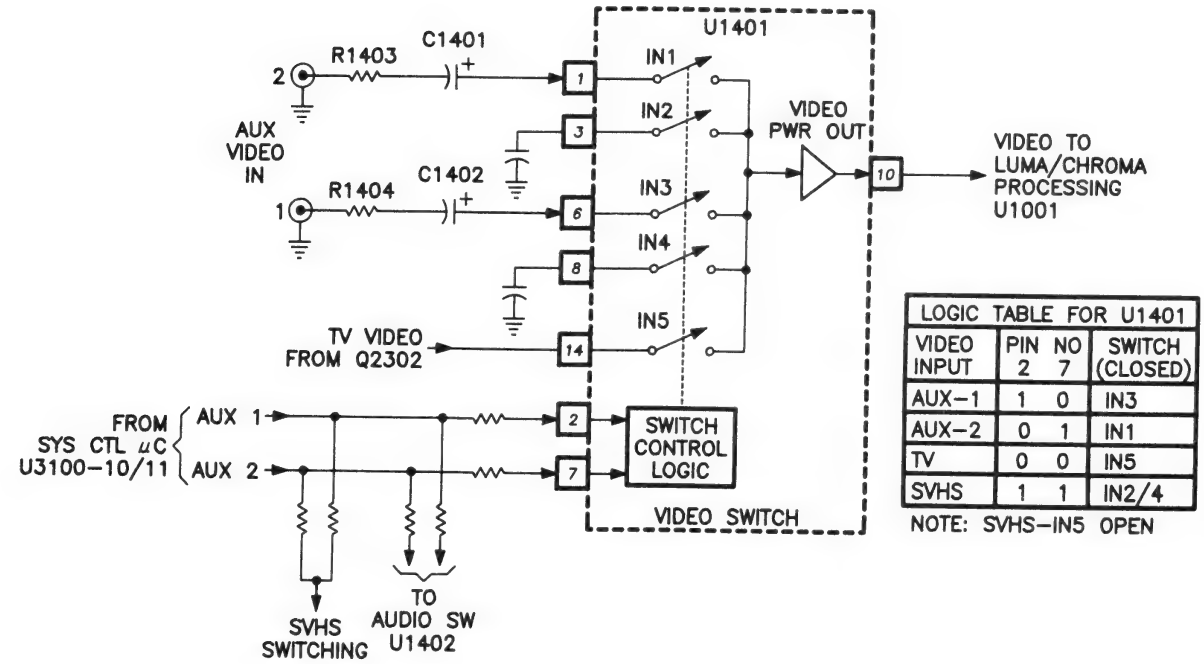
   Why? This only function missing is last at tuner/audio



Simplified Block Diagram



Low Level Video/S-VHS Input (CTC158/159)



Aux Video Switching (CTC158/159)

LOCALIZE

3. Check the one item listed below that you feel would quickly eliminate a large portion of the Signal Processing circuitry?

   ___ Check power supply to S-VHS switching circuit.

   ___ Check video from U1001-46.

   ___ Insert chroma and luma into S-VHS input jack.

   ___ Check Aux 1 and Aux 2 outputs from U3100-10/11.

ISOLATE

4. Check the major stages or components listed below that you feel might be at fault if the video returned when SVHS was inserted.

   ___ CTV Processor U1001.

   ___ System Control uC U3100.

   ___ Comb Filter CF2601.

   ___ Q2304 Video Buffer.

   ___ Q2850 Chroma Buffer.

   ___ Video Switching Circuit.

   ___ Q2302/03/04 Video Inv/Buffers.

5. Do you feel that the CTV Processor (U1001) could be at fault?

   Yes ___ No ___

   Summarize your reason.

   All functions are controlled by this IC. Audio OK

End of Exercise 4

NOTES

NOTES

NOTES

TV
Service Check List

Date: _____

Model #: _____ Customer: _____ Chassis #: _____

Reported Symptom: _____

1. PHYSICAL INSPECTION: _____

_____

2. OPERATIONAL CHECK:

	Yes/OK	No/Bad	Comments
Power On/Off (Local)			
Remote Operation			
Keyboard Operation			
Video (Luma)			
Video (Chroma)			
Raster (High Voltage OK)			
Vertical Deflection			
Horizontal Deflection			
Audio (Mono)			
Audio (Stereo)			
MTS/SAP			
O.S.D. (On-Screen-Display)			
Misc. Customer Controls			

Symptom (If different than above): _____

_____

3. **SECTIONALIZE:** Major Functional Group, I.E.; Power Supply System Control-Tuning/Signal Processing/Audio/Deflection.

Major TP's/checks:

TP/IC pins/connectors	Results

Major Functional Group Suspected: _____

Reason: _____

4. **LOCALIZE:** Major Circuit, I.E.; Power Supply/Start-Up/B + Regulator/ Deflection/Scan Derived Supplies/etc.

Major Tp's/checks:

TP/IC pins/connectors	Results

Major Circuit Suspected: _____

Reason: _____

5. **ISOLATE:** Stage or Component

Major TP's/checks:

TP/IC pins/connectors	Results

Stage or Component Suspected: _____

Reason: _____

THOMSON CONSUMER ELECTRONICS, INC.
TECHNICAL TRAINING

QUALITY OF TECHNICAL TRAINING SURVEY

This survey is to be used for evaluating the contents of the 1990 CTC156/57,58/59 TV Technical Training Manual. This form is pre-addressed and ready to be folded, stapled and placed directly in the mail.

YOUR NAME _____ DATE _____

YOUR COMPANY NAME _____

For each of the following, please place a check mark next to the *one* statement that *best* describes your opinion.

1. Amount of operational theory presented?

___ A. Generally about right

___ B. Too little in the following area(s)

_____

_____

___ C. Too much in the following area(s)

_____

_____

2. Amount of troubleshooting procedures presented?

___ A. Generally about right

___ B. Too little in the following area(s)

_____

_____

___ C. Too much in the following area(s)

_____

_____

3. Thoroughness of the information?

___ A. Seems to include all essential information

___ B. Contains more information than I need in the following area(s)

_____

_____

___ C. Is missing information in the following area(s)

_____

_____

4. Usefulness of information?

___ A. **Most** of the information is or will be useful to me

___ B. **Less than half** will be useful to me

___ C. **Very little** of the information will be useful to me

5. Ease with which you could understand the information?

___ A. Generally most of the content was easy to understand

___ B. **Some** information was difficult to understand because:

_____

_____

___ C. **Most** of the content was difficult to understand because.

_____

_____

6. What *one* thing did you like *most* about the Manual?

_____

_____

_____

7. What *one* thing, if any, did you like *least* about the Manual?

_____

_____

_____

Overall Rating

Please check the *one* response that most accurately describes your *overall rating* of this Technical Training Manual.

8. Overall content

___ A. Excellent

___ B. Good

___ C. Adequate

___ D. Unsatisfactory

Additional Comments: _____

_____

_____

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